Compressed Air Magazine

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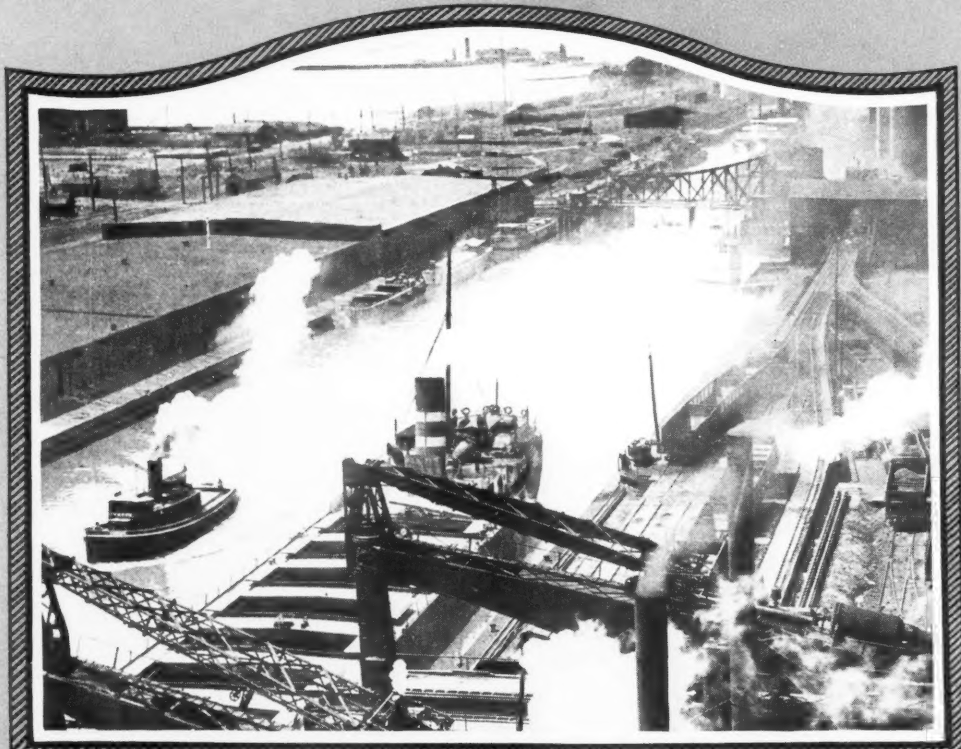

Ewing Galloway, N. Y.

PART OF BUFFALO'S EXTREMELY BUSY WATERFRONT WHERE ENORMOUS AMOUNTS OF GRAIN, ORE, AND OTHER BULK MATERIALS ARE HANDLED

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As It Seems To Us

WE HAVE OUR DOUBTS

PROUD parents the world over are fully aware of the superiority of their own offspring—this state of mind probably goes back to the very beginning of the human race; but these outstanding virtues are not so readily recognized by those not so allied by parenthood. Therefore, the doubting public generally should welcome the means devised by one of the faculty of Columbia University whereby the relative approach to the child of perfection can be ascertained simply by answering 1,911 questions after duly observing the antics of the offspring under consideration.

We are indebted to *The New York Times* for the following particulars of the procedure evolved by Dr. RUTH ANDRUS, associate professor of education. Just keep these particulars in mind, and the problem will be an easy one to solve: "The perfect child goes to school because he likes to go; and, though he is well versed in all the artifices for escaping from the tedium of the classroom, he never takes advantage of them. On the other hand, he does not hesitate to knock down little girls when they trespass on his rights by trying to snatch his hat.

"This curious child always knows his birthday; never forgets where he lives; never has to be reminded to hang up his clothing or to take off his shoes before lying down for his afternoon nap; never addresses adults unless he is spoken to; and never says 'It is me' for 'It is I'. He can remember experiences for twelve months. The perfect child on the motor side, can button and unbutton his jacket in the back without waiting for his mother; and he can dress and undress by himself, arrange his garters properly, and manipulate galoshes, zippers, and shoe laces.

"On the social-moral side he is even more perfect. He is coöperative and friendly; recognizes the rights of others as well as his own; is a natural leader in group activities; and when crossed exercises rare self-control. His parents never have to remind him to say 'Please' and 'Thank you'. Finally, this child has no bad habits: he places his hand over his mouth when he sneezes and also when he yawns. He accepts punishment without marked resentment; is a model of generosity; and never bosses, pinches, or teases his fellows."

The foregoing covers some of the outstanding characteristics of children between two and five years of age, as observed by the originator of a yardstick for measuring juvenile personality. We are sure that many of the youngsters of our acquaintance must have been outside the scope of Dr. ANDRUS' inquiry or have outgrown the infantile charms that once were theirs. Even so, we do know many youngsters that appeal to us strongly because of their human, likable qualities, although a good hickory limb may and should be applied, from time to time, in taking their measure. We are a bit leery of any youngster rating well up towards perfection of conduct.

OUR MINERAL PRODUCTION LAST YEAR

DURING the year gone, mineral production in the United States had an estimated value of about $5,900,000,000, and represented a 10 per cent increase over that of the preceding twelvemonth. The especially interesting angle of this announcement by the Bureau of Mines is that the non-metallic output was lower than in 1928, while the output of petroleum, natural gas, coal, copper, and iron was higher in each case during 1929 than it was the year before. We do not have to remind our readers that the minerals showing gains are those intimately identified with power production and with the making and fabricating of endless commodities turned out by plants and factories of many and divers sorts.

IN QUEST OF PURE AIR

VARIOUS articles in the daily press, during the past twelve months, have stressed the more or less polluted condition of the atmosphere breathed by people in the City of Greater New York. Figures have been presented intended to reveal just how much soot and grime settles upon the average square foot of exposed surface within the municipality every 24 hours. The data is disquieting to those that pause and ponder; and the health authorities have set about modifying the evil by prodding the officials directly responsible for the enforcement of the smoke-nuisance ordinance.

Needless to remark, the activities of these gentry have aroused antagonism on the part of tugboat owners, industrial-plant managers, and scores of others having boilers that send clouds of smoke more or less intermittently skyward through associate chimneys. These offenders believe the situation to be painted blacker than it is in reality. Accordingly, various apparatus have been employed to bolster up the arguments advanced by the health authorities. The latest of these instruments is what is known as an Owens automatic air filter, and is so designed that it will register continuously night and day the relative cleanliness of the surrounding air.

This filter inhales the atmosphere—taking in two liters of air every quarter of an hour, and the deposit left successively on the filter paper is compared with a certain number of standard shades. In this way it is possible to ascertain closely the measure of solid matter carried by the atmosphere at any time. In the case of New York City, the inhaled air has been found to be generally nearest to pure at four o'clock in the morning. Apart from the hygienic significance of this discovery, we may find here an explanation of why the cabaret and the night club flourish as they do in Manhattan. Is it not likely that this is an impulsive and natural effort on the part of the denizens of the city to protect themselves against the physical hazards of the daytime bad air by breathing as much as they can of the clean air of the "wee small" hours? Of course, the outstanding drawback to this procedure is the utter dryness of the tonsils afterwards.

OUR MERCHANT MARINE TONNAGE MOUNTING RAPIDLY

IT is a source of much satisfaction to all interested in America's merchant marine to learn that shipbuilding in the United States gained 38 per cent in tonnage during last year. As a matter of fact, shipbuilding increased here at a much greater rate than did that department of industry in any other maritime nation during the same twelvemonth.

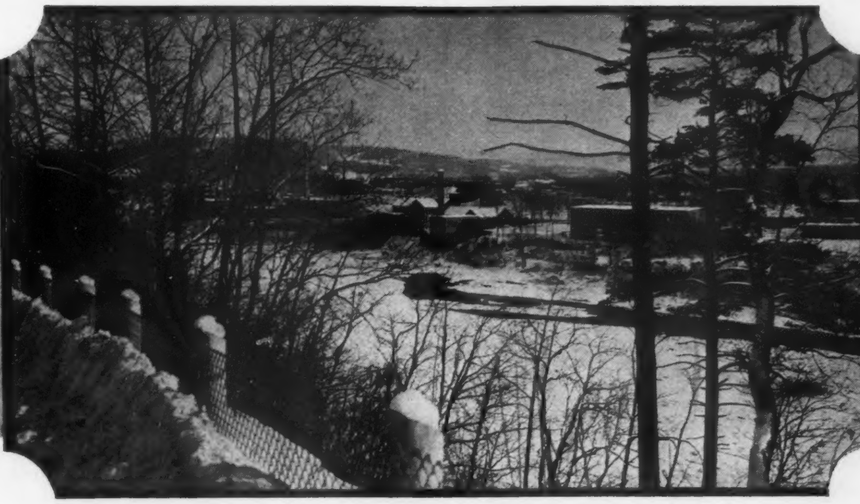
Our shipyards began 1930 with unfinished business at hand worth $70,000,000 more than the total work at hand at the beginning of 1929. Ordinarily, naval building represents a notable proportion of the annual construction of new vessels; but the year gone was especially marked by the large amount of merchant-marine tonnage, and 1930 promises to carry this trend still farther.

The strenuous years of the World War—particularly the early ones, brought sharply to the attention of the public how much we had to depend upon foreign craft to carry the great bulk of our exports and imports; and because of our relatively modest showing upon the sea in the form of merchant vessels we were gravely hampered in providing experienced personnels for the ships of trade and other non-combatant craft built and outfitted during that anxious period. We are reminded just once so often that we had to rely to a very large extent upon foreign vessels to carry men and supplies to Europe after we entered the conflict.

The steady upbuilding of a merchant fleet commensurate with the wealth and industrial life of the country, and with our participation in world trade, is something that should be vigorously encouraged by every patriotic American. Our shipyards should be kept busy, and everything within reason done to keep that department of our industrial life on a parity with every other field of essential endeavor within our gates.

Ewing Galloway, N. Y.

Famous statue of Abraham Lincoln, by Saint Gaudens, in Lincoln Park, Chicago.



Industrial plants operated by power developed at Turners Falls.

Forming of Troublesome Ice Prevented By Jets of Compressed Air

By J. S. MEEHAN

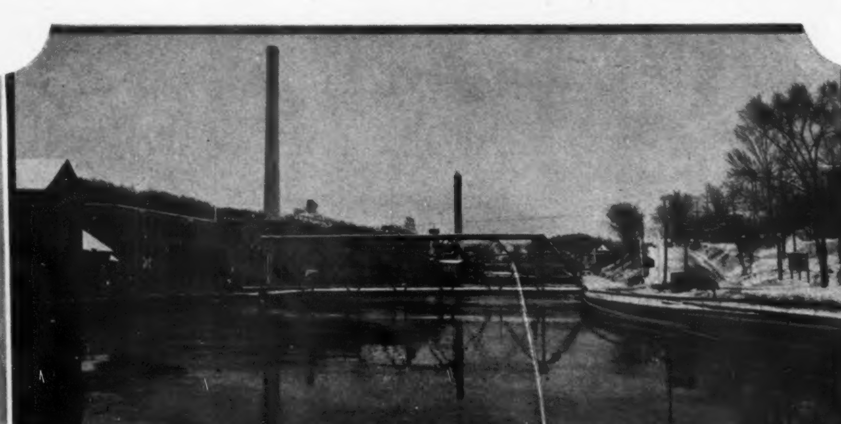
"UP there, Winter lingers so long in the lap of Spring as to occasion comment!" At least, that was Josh Billings'suggestive way of humorously describing a seasonal hesitation to change in a certain part of New England.

The present article has to do with another section of the same group of states where the winters are commonly severe and often produce troublesome accumulations of ice that tend to hamper the wheels of industry. In the case of the power plant to be dealt with, however, we have another example of the effectiveness of compressed air in neutralizing natural conditions so that turbines can be run whenever they are called upon to furnish needful electric energy. We refer to what is known as Station No. 1 by the Turners Falls Power & Electric Company.

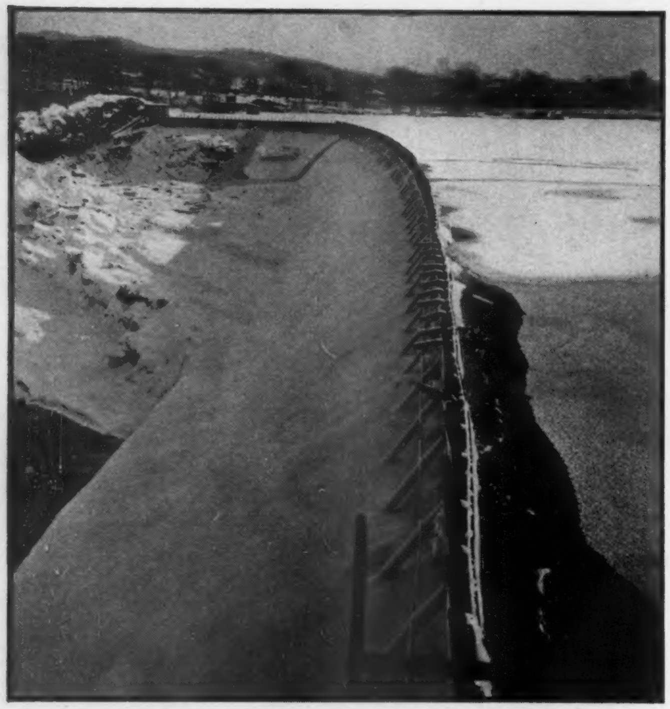
The Village of Turners Falls lies within the limits of the old Town of Montague, in the northern and western part of Massachusetts; and there mills of one sort or another have been in operation for generations—indicating a manufacturing line of effort so characteristic of the State for a century and more. From the earliest days, the people of Massachusetts have made use of power obtainable from falling waters; and streams and rivers were dammed at strategic points in order to develop heads for the turning of simple forms of water wheels. It was this pioneer effort that took legal form in 1794 through an act of the legislature that called into being the Proprietors of the Upper Locks & Canal Company, and empowered that concern to do business and to regulate the flow of the Connecticut River within a stretch that embraced the Township of Montague.

Agreeably to that authorization, the proprietors dug a canal and built locks—the idea being to promote navigation as well as to facilitate the operating of water wheels. Eventually, the use of the canal for transportation was abandoned and attention was concentrated, in the main, on providing power for mills of various kinds. Such was the industrial situation when the Turners Falls Company was organized in 1866. At that time, and for years afterwards, the water wheels were of simple, relatively inefficient types, and were used for the direct driving of machinery or of shafting connected by multiple belts with the different departments of a mill or factory. It was not until turbines, hooked to electric generators, came into vogue that the engineering character of the plants at Turners Falls underwent a change. Then it was that the Turners Falls Company became the Turners Falls Power & Electric Company, and its field of service broadened in direct proportion as the company was able to transmit current farther and farther from the source or sources of generation. This sequence of development is similar to that of most of the power companies of New England that have been the outgrowth of plants utilizing water wheels of one form or another.

In 1904, the Turners Falls Power & Electric Company built Station No. 1, with an operating head of 40 feet. This plant is within the Township of Montague. In 1915, the company completed a second hydro-electric station, known as the Cabot Plant, some miles farther down the Connecticut River. Station No. 1 has an installed capacity of 5,320 kw., while the second and larger power house is capable of developing 51,000 kw. Ordinarily, the Cabot Plant is able to take care of the normal load and to utilize the water reaching it at a head of 60 feet. Station No. 1 is maintained today as a stand-by for the Cabot Plant; but during spring and fall high-water periods the station is run to take advantage of the freshets. At those times—covering a total duration of from four to five months—this surplus current is transmitted at 66,000 volts to the lines of the New England Power Association.



Canal at Turners Falls and some of the large industrial plants drawing power from that artificial waterway.



Dam at Turners Falls, Mass. The midstream ledge shows at left of the picture.

these intake gates is equipped with a rack to keep out trash and floating ice—the gate valves being a few feet back from these racks. At the southern end of the forebay or powerhouse canal there is a sluice gate designed especially as an outlet for ice accumulating in the forebay.

The long side wall of the canal, in which the intake gates for the turbines are set, constituted a problem for the operating superintendent in charge of the dam and Station No. 1, especially in the wintertime when "shell ice"—that is, surface ice—formed in the forebay and attached itself to the side walls of that pond. When the water level fell, the ice dropped with it and, being attached to the side walls, exerted an inward-pulling stress. Conversely, when the water level rose again it lifted the ice and caused a lateral thrust, which induced on one or two occasions force sufficient to fracture the western wall. Happily, the situation was discovered in time to avoid grave consequences. It is easy to understand that the pull on the wall exerted by the attached ice became greater whenever a current was set up by water flowing to the penstock intakes.

Needless to say, to serve its present purpose, Station No. 1 must be held continually ready to perform efficiently in case of any failure on the part of the Cabot Plant; and this article has to do with certain precautions that have been taken to keep Station No. 1 fit for a sudden demand in the wintertime.

Adjacent to Turners Falls is an industrial community of considerable size where manufacturing plants are engaged variously in turning out newsprint, magazine paper, fine writing and bond paper, and onion-skin paper employed extensively in the making of manifolding carbon paper. Still other factories are devoted to the production of fine cutlery, cotton textiles, silk cloth, and fishing rods and allied equipment; and, besides, there are several machine shops. The water utilized by these plants for power and manufacturing purposes reaches them by way of a canal, which they flank. This canal, in its turn, is fed from water impounded by the dam reared across the Connecticut River at Turners Falls. This dam has a total length of 1,175 feet, a height of 33 feet, and is a concrete structure. The dam is in two sections that are tied in the center to the natural ledge which rises at that point in the river. The gatehouse which regulates the admission of water to the canal is at the east side of the river. The water level can be raised above the structural crest of the dam by flashboards. These are held in place by 365 pins made of suitable lengths of 3½-inch boiler tubes.

Station No. 1 is located below the industrial center of the community and down near the bank of the stream. Water for the operation of the plant is diverted from the main canal into a smaller canal, 24 feet deep, that virtually serves the purpose of a forebay. On the west side of this forebay there are four intake gates connecting with four penstocks leading down to the nearby station. Each of

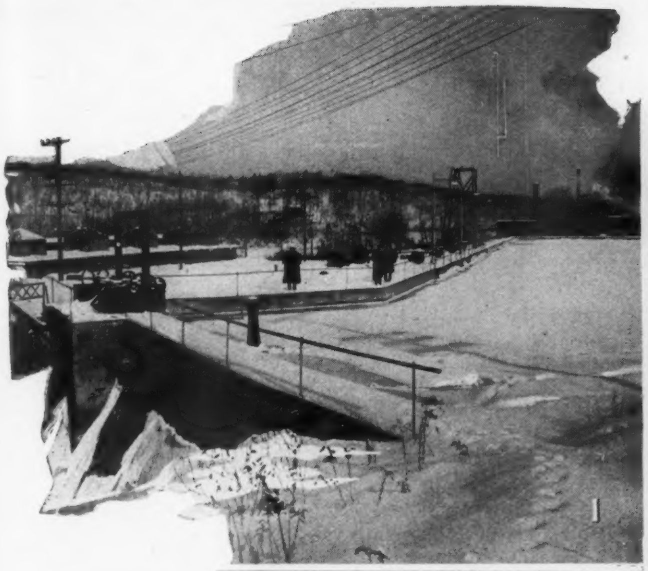
Mr. George E. Farmer, in charge of plant operations, found it necessary, over a term of years, to cut twice each winter a channel 8 feet wide along the intake side wall from the intakes northward for a distance of 600 feet. That freed the side wall from the menacing drag of attached ice; but it incidentally required each time the services of fifteen men armed with ice chisels and entailed a seasonal outlay of $500. Only by continual watchfulness was it possible to protect the wall from the development of damaging ice pressures; but despite that watchfulness the wall was fractured. This made it clear to Mr. Farmer that some other means should be provided to keep the western wall free from ice, at least from the southernmost penstock intake northward to the turn of the canal; and he believed that the submerged discharge of compressed air would prove effectual. The novelty of the scheme made him hesitate to discuss it with his superior officers until he had given the method an experimental test. Mr. Farmer thus describes his procedure:

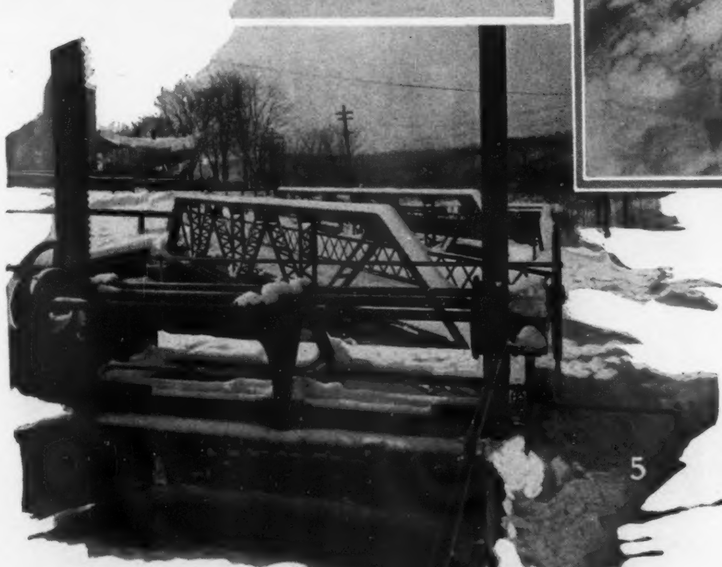
"Three winters ago, I hung 1¼-inch pipe along the west wall at a depth of 12 feet. The pipe was perforated at intervals of 3 feet with holes tapped for ¼-inch brass plugs that were screwed into the pipe to a depth of ⅛ inch. In each plug was drilled a hole 1/64 inch in diameter; and the line so fitted was connected with a compressor that furnished air at an average pressure of 10 pounds. Throughout that season the bubbles of compressed air rising surfaceward were effective in preventing the 'shell ice' from attaching itself to the section of the side wall so protected. This made it unnecessary for us to use, at any time, men with cutters to clear away the ice as had formerly been our custom.

"With that performance to the installation's credit, I reported the matter to the company's officials, and obtained their sanction to extend the system and to purchase an air compressor capable of meeting all our ice-defense needs. Ice clinging to the side walls of the forebay was not the only way in which ice gave us trouble. In cold weather the valve stems at the penstock intakes would freeze in so that it was impossible to operate the valves until after we had turned a jet of water, from a hydrant, on to them for two hours or more. Similarly, the sluice gate at the southern end of the forebay would be frozen tight and require half a day to thaw it out with a water jet. In an emergency the freezing of the valve stems or of the sluice gate might have caused a costly delay, if nothing else, in starting up or operating Station No. 1.

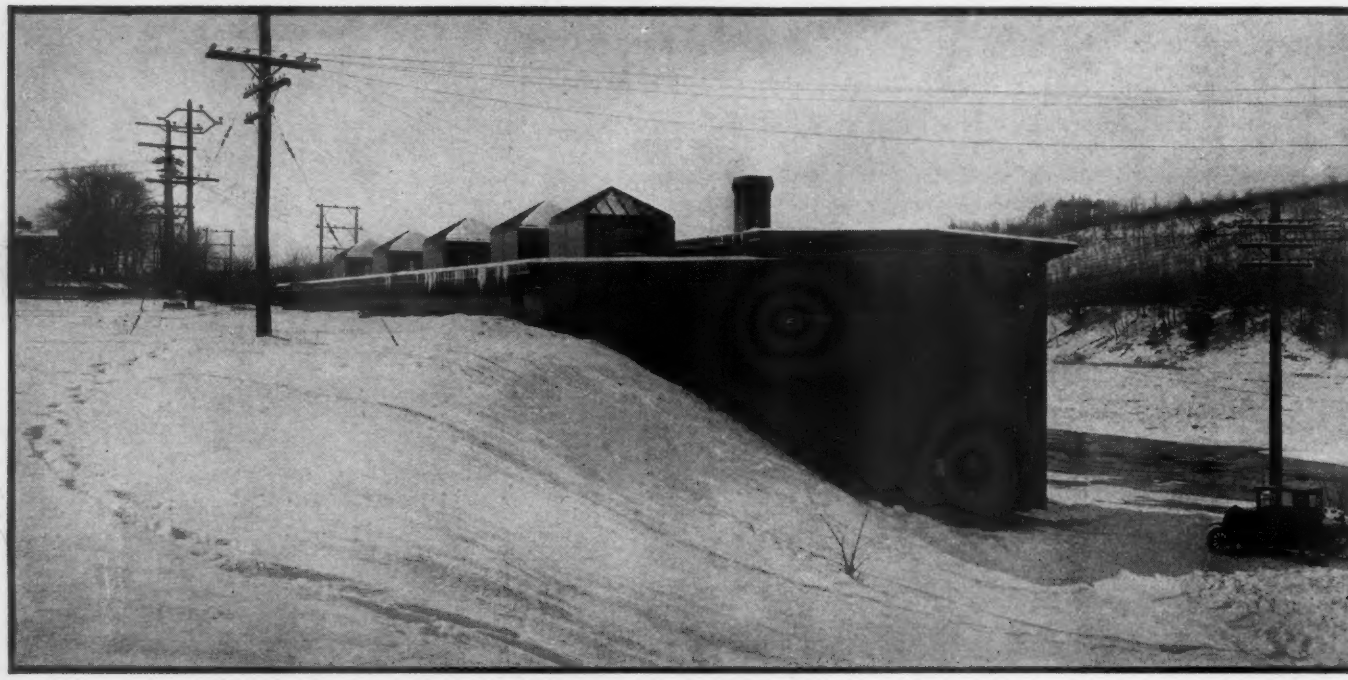
"Having demonstrated what could be done with compressed air in preventing ice

Top—Gatehouse and associate section of the dam at Turners Falls. Bottom—Power canal just below the gatehouse at the Turners Falls dam.





1—Forebay or canal serving Station No. 1, the roof of which is visible at the left. 2—Mr. George E. Farmer standing by the valve operating gear of one of the penstocks. The picture shows part of the piping system carrying compressed air to a submerged valve stem. 3—Turbine-driven generators in Station No. 1. These machines have a combined capacity of 5,320 kw. 4—This photograph shows the 600-foot section of the western wall of the forebay or canal kept free of surface ice by the submerged discharge of compressed air. 5—Sluice gate at southern end of the canal used intermittently to clear accumulating ice from the forebay at Station No. 1. Submerged air jets keep the gate free of ice so that it can be operated at any time during the winter season.



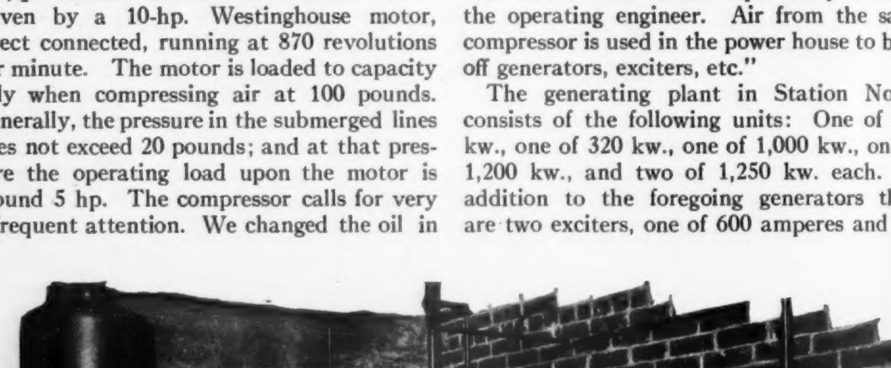
Station No. 1 of the Turners Falls Power & Electric Company. Operating water is obtained from a canal at the left and beyond the range of the photograph.

attaching itself to the side wall above the jets, it was not difficult to obtain authority to go ahead and fit each intake-gate valve and the sluice gate with a kindred outfit. Accordingly, a 1-inch pipe, connecting with a $1\frac{1}{4}$-inch main, was run down into the well between the intake rack and the valve and fitted with a $\frac{1}{4}$-inch plug discharging air through a $\frac{1}{64}$-inch hole at a point where the air would rise around the submerged stem of the valve. Above the sluice gate was placed a 1-inch, horizontal supply pipe from which a $\frac{3}{8}$-inch feeder was led down on each side of the gate. Air discharged from the bottoms of the feeders has kept the gate clear of ice in the same way that the penstock-valve stems have been maintained in condition to be opened instantly upon demand.

"The whole arrangement is so simple and its practical value so clearly established that one naturally wonders why this method of ice defense is not more widely employed. Whenever the thermometer dropped low enough to promote the rapid formation of ice, my worries began and recurred frequently until we put in the pneumatic outfit. Of course, it was not feasible to keep men always on the job breaking 'shell ice' that attached itself to the western side wall of the canal; and yet I never knew what might happen overnight. The one serious breach of the side wall showed me just what might take place between sunset and sunrise when all seemed well the evening before. Further than that, the ice in the center of the pond would crack and break with changing levels of the water, and the broken masses would pile upon one another and add to the accumulating weight tied to the side walls. This ice then needed only another change of water level to exert a dangerous thrust or pull upon the masonry walls. I mention these conditions in order that the benefits derived from the compressed-air equipment may be properly evaluated.

"The compressor that now serves this ice-defense system was purchased two years ago last fall, and was installed in the power house of Station No. 1. This unit is what is known as a Type 20 stationary compressor, made by the Ingersoll-Rand Company; and it has a $4\frac{1}{4}$-inch bore and a 4-inch stroke. It is driven by a 10-hp. Westinghouse motor, direct connected, running at 870 revolutions per minute. The motor is loaded to capacity only when compressing air at 100 pounds. Generally, the pressure in the submerged lines does not exceed 20 pounds; and at that pressure the operating load upon the motor is around 5 hp. The compressor calls for very infrequent attention. We changed the oil in the machine in the fall, and the unit has been running continuously since then without any upkeep outlay. This merely serves to emphasize the dependence that can be placed upon such a plant when once hooked up; and it also makes it clear that such an installation adds but a trifle to the supervisory work of the operating engineer. Air from the same compressor is used in the power house to blow off generators, exciters, etc."

The generating plant in Station No. 1 consists of the following units: One of 300 kw., one of 320 kw., one of 1,000 kw., one of 1,200 kw., and two of 1,250 kw. each. In addition to the foregoing generators there are two exciters, one of 600 amperes and the



Motor-driven Type 20 compressor which furnishes air for the ice-defense system installed at Station No. 1 of the Turners Falls Power & Electric Company.

Gate-control machinery in the gatehouse at Turners Falls.

other of 1,600 amperes. Manifestly, it is highly important that this plant shall be ever ready to run either when there is a superabundance of water or when the larger and steadily operated plant, farther down the river, is partly shut down or completely out of service for any reason. It was with a consciousness of the emergency importance of Station No. 1 that Mr. Farmer devised the installation which has demonstrated during three winters its effectiveness in preventing the formation of hampering ice at critical points in the forebay and the intakes.

The use of compressed air in checking troublesome ice is not, in itself, novel, but the services performed at Turners Falls are different from any hitherto described by us, although not dissimilar in principle because they all rely upon the agitation of the water and the relative warmth of the air to prevent the freezing of the water. Possibly what Mr. Farmer has accomplished may be an aid to others having kindred conditions confronting them. His example will show them how they, too, can save money and lessen their operating worries.

MILE-LONG VACUUM TUNNEL TO MEASURE LIGHT'S SPEED

SCIENTISTS of the Mount Wilson Observatory, in California, are having built near Santa Ana, a mile-long vacuum tunnel that is to aid them in measuring the velocity of light. Inside and throughout the length of this tube, which has a diameter of 3 feet and is being constructed of corrugated steel, will be placed a series of mirrors and numerous tiny motors. The latter will be controlled from without and will furnish power to adjust the mirrors.

As soon as the first tube-section, with a length of 1,100 feet, is completed, tests will be made in order to determine its efficiency as a vacuum chamber. By the use of this tunnel the astronomers hope to eliminate the atmospheric interference that was encountered when gaging the speed of light between Mount Wilson and Mount Baldy, a distance of 23 miles, and thus to obtain more accurate measurements.

A new road material, consisting largely of oil shale, is being produced in Melbourne, Australia, and has been found to be a satisfactory substitute for bitumen, of which increasingly large quantities have been imported yearly for roadbuilding. When mixed with coal tar, the substance forms a plastic mass that is suitable both for binding and surfacing. Sections of streets given a top coating with the new compound more than a year ago have stood up well, it is said, under heavy traffic.

HEIGHTENING ASSUAN DAM

THE special commission appointed by the Egyptian Government in November of 1928 to inquire into the practicability of increasing the height of the Assuan Dam, in order to impound more water, has reported favorably on the project. The work is now in progress; and, if all the recommendations made by the commission are carried out, it means: first, adding 29.5 feet to the height of the dam—the present width of the roadway on top being retained: second, building new buttresses on the downstream side of the dam between each pair of sluices—the buttresses varying in width and tapering from 19.75 feet at the bottom to 3.25 feet at the crest; and, third, strengthening the existing buttresses by making them conform in size to those to be added. The new buttresses are to have no fixed contact with the existing masonry.

PHOTO-ELECTRIC CELL PERFORMS MANY SERVICES

LONG merely a laboratory curiosity, the photo-electric cell or electric eye, as it is more commonly called nowadays, is coming into its own by performing many useful functions that are of inestimable value to industry. For example, its watchfulness assures efficient combustion in boiler plants. From a lamp, on one side of a stack, a ray of light passes through the flue gases to a photo-electric cell on the opposite side. The opacity of the gases is measured by the amount of light that gets through, and is indicated on a meter in the fireroom. Installations of this kind have proved that the character of the flue gases is a fair gage of the fireman's skill or lack of skill and have made it possible to maintain fairly clear stacks.

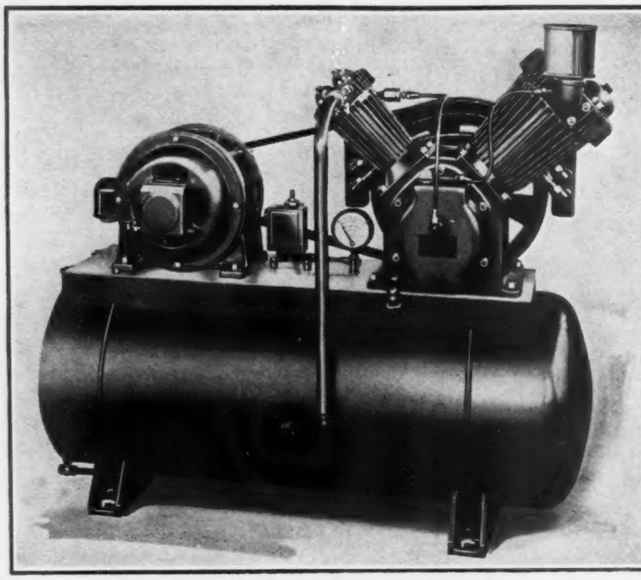
In controlling factory lighting the electric eye is doing valuable work especially in reducing eye strain by turning on the lamps at the proper time. As daylight waxes and wanes, the lamps are switched off and on by the sensitive photo-electric cell. In one instance, two sections of a shop, each illuminated with lamps aggregating 8,000 watts, were controlled, respectively, by photo-electric cells and by the workers. After a 3-months' test it developed that the section in charge of the workers had consumed two and a third times as much power as the area taken care of by the electric eye.

Serving for what might be called "the brain" of many devices, the photo-electric cell counts sheets of paper at the rate of 60 a second; rejects defective pieces from a moving production line; holds open the doors of automatic elevators as long as passengers are getting on and off; and turns on a fire-smothering gas when smoke, from one source or another, comes between the beam of light and the electric eye. These are but a few of the present-day applications of the photo-electric cell, the possibilities of which are just beginning to be appreciated by the engineering world.

A display of roadbuilding machinery at the Varmland Exhibition, Karlstad, Sweden. These Ingersoll-Rand portable compressors and pneumatic tools aroused much interest when demonstrated before the visiting Swedish Road Builders' Association.

COMPACT COMPRESSOR PLANT HAS MANY USES

A NEW line of air-cooled, self-contained 2-stage compressors, known as Type 30, has lately been announced by the Ingersoll-Rand Company. The design is exceptionally compact—the motor and the compressor being mounted on a steel base which, in turn, is mounted on top of an air receiver made of heavy, pressed steel to carry a working pressure of 200 pounds. By this arrangement the compressor and the motor are always in proper alignment; no special foundation is required; and the machine is ready to operate as soon as its crankcase has been filled with oil and the electrical connections have been made. The drive is with a V-type belt.



The new Type 30 compressor made by the Ingersoll-Rand Company especially for use in small plants.

The compressor is started and stopped automatically by a standard type of control mechanism that operates independently but in conjunction with the machine's unloader. When the pressure in the air receiver has reached a given point, the automatic unloader shuts off the motor. A centrifugal governor permits the air in the high-pressure cylinder and the intercooler to exhaust through the crankcase. This prevents the compressor from starting against a load. The intercooler is located behind the fan-type flywheel, which sends a constant current of circulating air directly across the cooling coils. This reduces the temperature of the discharge air.

According to the manufacturer: Honed cylinders and two oil control rings reduce to a minimum the amount of oil carried in the discharge air; and each piston is run into its respective cylinder, thus insuring a perfect oil seal. The base of the compressor unit serves as a reservoir for the oil; and a bayonet gage indicates the quantity of oil contained in the reservoir. No oil pump is required.

The compressor is completely encased so as to keep abrasive dirt and grit away from the working parts, and it is provided with an air cleaner that requires no attention. Ball bearings assure smooth running of both the motor and the compressor; and a balanced crankshaft obviates destructive vibration.

This new type of 2-stage compressor comes in four sizes—¾, 1½, 3, and 5 hp., but all are built for a working pressure up to 200 pounds continuous duty. Because they are so compact they take up comparatively little floor space; and their power requirements are said to be anywhere from 10 to 30 per cent less than for compressors of like sizes and capacities.

REFRIGERATING MACHINERY IN THE AUTOMOBILE PLANT

WHAT need is there of a refrigerating plant in an automobile factory? Well might the uninitiated ask the question because refrigeration and motor cars do not seem to have any connection. They have, however, as it is the cold room in the modern automobile plant that enables the engineers to design cars that will meet winter conditions.

Engines, starters, carburetors, oil pumps, and other parts that are affected by low temperatures are tested in the cold room. There, too, is determined the behavior under a wide range of low temperatures of such materials as bakelite, rubber compounds, paints, etc., that enter into the manufacture of an automobile. The men in charge are protected against the cold by clothing such as aviators wear when flying at high altitudes.

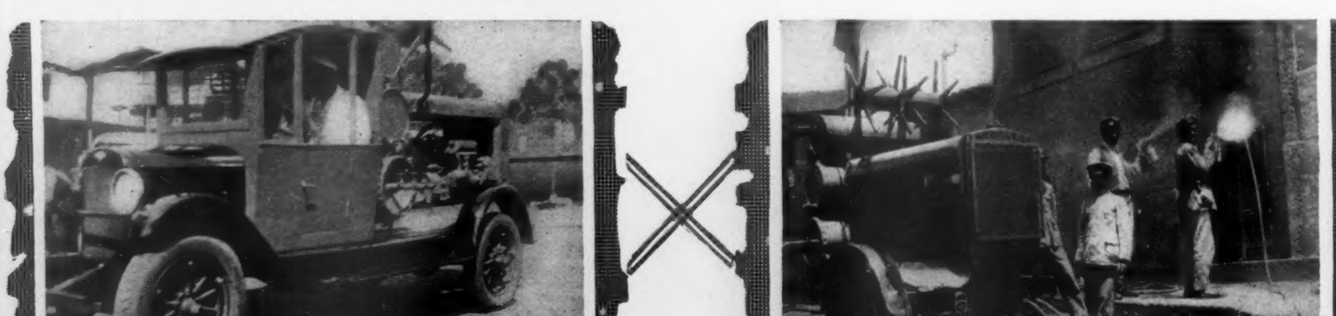
In one particular factory the ammonia-compressor plant provided for this purpose is capable of producing 60 tons of ice every 24 hours. This capacity is, of course, greatly in excess of ordinary requirements, but it is needed in order to lower the temperature of the room quickly when setting up a new engine for testing. The minimum temperature obtainable is 45° below zero Fahrenheit. The cooling system is automatically controlled; and, once an engine is in position, it can be put through its paces without continued attendance. It is operated by remote control, and its performance—that is, its speed, power output, fuel consumption, oil pressure, and the temperatures of different parts of the engine, are registered on suitable instruments and gages in an adjoining room that is comfortable to work in.

According to reports from Germany, a motor truck has been run successfully with gas made right on the truck by a miniature gas plant. The gas is generated from brown coal that is in the form of briquettes. These are put in the apparatus, the resulting gas being purified and mixed with air before passing into the motor. It is claimed that this gas is as efficient as other motor fuels, and that it is 90 per cent cheaper than gasoline.

PORTABLES IN PUBLIC HEALTH SERVICE

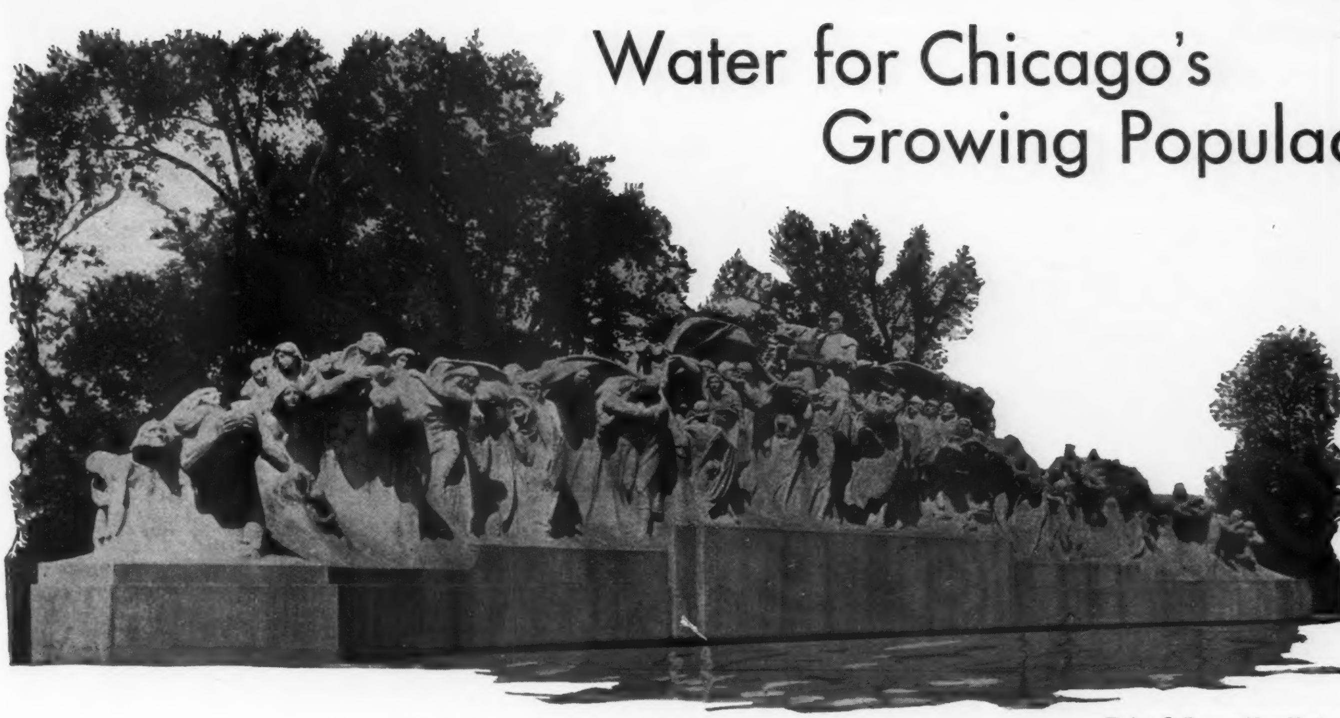
THERE seems to be no end to the unusual uses to which portable compressors are put by the enterprising, and this is attested to by the accompanying photographs. These machines, two of a group of seven, are in the service of public-health departments that are finding them invaluable in getting over ground that must be fumigated or disinfected, or in killing mosquitos or other insect pests.

To each compressor are attached numerous spray guns—the hose connection, in each case, being long enough to reach inside of buildings. The spray guns are of the de Vilbiss type with suction feed cup attachment, and anywhere from one to fourteen of them can be used with one portable, depending upon the size of the machine. A 5½x5-inch unit is capable of supplying sufficient air for ten such guns when they are being operated continuously at 90 pounds pressure.



These up-to-date portable compressors are used extensively for fumigating purposes by an energetic Health Department

Water for Chicago's Growing Populace



Fountain of Time, by Lorado Taft, in one of Chicago's parks.

Ewing Galloway, New York

By JOHN N. THORP, Jr.

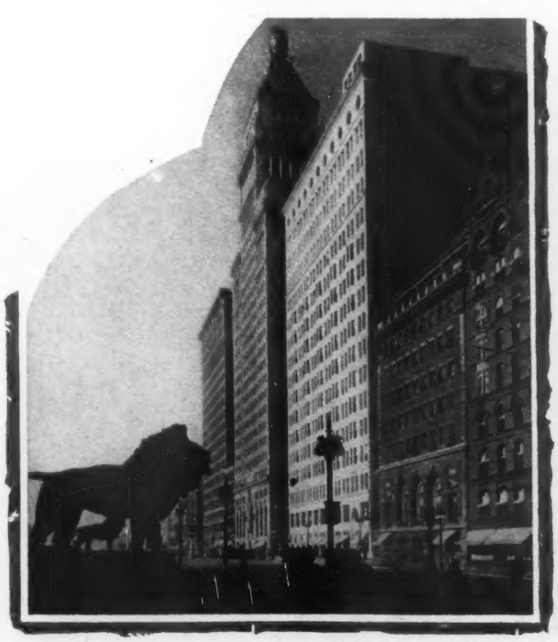
SINCE 1840, when some of Chicago's 4,479 inhabitants had to buy water from peddlers at ten cents a barrel, that community has expanded steadily, and today numbers more than 3,150,000 people requiring substantially 923,000,000 gallons every 24 hours. In the course of the past 90 years, Chicago's water-supply system has developed from a modest privately owned affair to the present great municipal system that is now being enlarged to meet future needs. The story of this achievement in water-works engineering is one that virtually covers all progress that has taken place in this vital department of municipal life during those nine decades.

In the early "thirties", when Chicago numbered about 350 people and was confined to an area within a good stone's throw from the river of the same name, the supplying ot water was a simpler proposition than it is today, but the cost of the service was relatively higher. Then a public well, sunk at an expenditure of $95.50 on the North Side, constituted the town's water works. This well helped to serve the residents in that section even after Chicago was incorporated, in 1837, and after the first real water-supply system was put in operation in 1840. The latter system was built on the south side of the river by the Chicago Hydraulic Company—a private enterprise, and consisted of a 25-hp. pumping engine, a 1,500-gallon storage tank placed at an elevation of 80 feet, two miles of bored log mains from 3 to 5 inches inside diameter, and 150 feet of iron intake pipe that extended out into Lake Michigan.

This plant met the requirements of the fast-growing community only for a few years; and in 1851 the franchise of the Chicago Hydraulic Company was taken over by the municipality. A new water-works system was planned with three elevated wrought-iron reservoirs holding 500,000 gallons each and a network of 30 miles of distributing mains reaching out into the north, south, and west sections of the city. By that time the population totaled 66,000, and the consumption per capita was 8.9 gallons daily. Five years later, after the pumping capacity of the station had been doubled, there were 94,000 people in Chicago using 3,900,000 gallons per day, or 41.2 gallons per person.

The first municipal water works was situated on the lake front, and about on the site of the present Chicago Avenue Pumping Station. But instead of the tall apartment hotels and the expansive Northwestern University grounds that now meet the eye looking eastward from that spot, the region roundabouts was a sandy waste in the days when those early city fathers authorized the construction of the system that they believed would meet the city's needs for years to come.

As originally planned, the intake for the pumping plant was to consist of a submerged timber crib, to be placed at a point in Lake Michigan about 600 feet out from the shore, and of a 30-inch-diameter timber pipe to be laid in a trench on the lake bottom. This pipe was to carry the water from the crib to a suction well in the engine house. However, heavy seas interfered to such an extent with the crib and the pipe work that the idea of an offshore intake had to be abandoned. Instead, a 30-inch intake pipe close to the shore and protected by a tile breakwater was built. But this was soon found to be unsatisfactory, and was replaced by a rectangular intake of oak planking and 3x4 feet in diameter.



Ewing Galloway, New York

Section of Michigan Avenue with its imposing array of business buildings.

On December 16, 1853, the steam-driven pumping engine, which had a capacity of 8,000,000 gallons daily, began to operate. For four months "Old Sally", as it was called, was on duty nine hours each weekday. Sundays it was idle, except in case of fire. After that, however, the increasing demand for water made continuous pumping necessary. "Old Sally" helped to supply the City of Chicago with water for half a century, a period marked by radical changes in water-works equipment and design. It would be interesting to contrast that old machine with one of the modern centrifugal pumps that is capable of deliver-

Ewing Galloway, New York

Left—Part of Chicago's skyline, viewed from across the winding Chicago River with Lake Michigan in the distance. Right—New Boulevard Bridge, where Michigan Avenue crosses the Chicago River.

ing 80,000,000 gallons every 24 hours, but space forbids going into detail.

But before long, the authorities were face to face with another problem that called for prompt action. It will be remembered that the Chicago River then flowed east and emptied into Lake Michigan, carrying with it an increasing quantity of sewage and industrial waste as the city continued its phenomenal expansion. Lake Michigan was Chicago's logical source of water supply; but something had to be done to stop the pollution of those waters that threatened the health of the populace. Various corrective measures were proposed and discussed, and it was finally decided by the Board of Public Works to construct a new intake in the form of a brick-lined tunnel two miles long, having an inside diameter of 5 feet, and extending from the existing pumping station to a crib out in the lake. This was considered a daring scheme at the time, and there were many that predicted its failure. On January 16, 1864, Congress approved the legislative act giving the city the right "to extend aqueducts or inlet pipes into Lake Michigan so far as may be necessary to insure a supply of pure water and to erect a pier or piers in the navigable waters of said lake for the making, preserving, and working of said pipes or aqueducts."

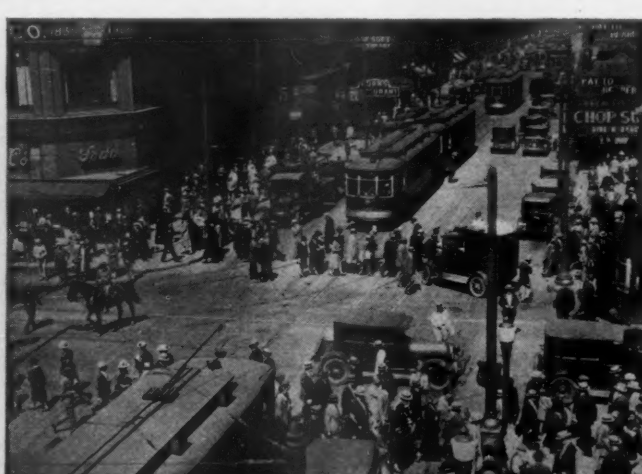
The project which marked the beginning of the great tunnel system, which is now being extended, was started on St. Patrick's Day, following, with the sinking of a shaft on the waterfront. The tunnel was driven at a depth of approximately 65 feet below the surface of the lake and through the blue clay characteristic of the region. Even so, owing to a lack of modern machinery and methods, the work was done under great difficulty. In July, 1865, the crib was launched and towed to its site out in the lake. To quote a contemporaneous issue of Harper's Weekly, the crib was "of monster construction composed of huge timbers and iron". Upon the completion of the offshore shaft, tunneling and brick-laying were begun at that end—the two headings meeting on November 25, 1866. Just four months later, the new intake tunnel was formally opened to service.

That tunnel may well be said to have been in the nature of an experiment; and that it was considered so by the city officials can be gathered from the fact that for several years following its construction the annual report of the Board of Public Works unfailingly stated that the tunnel was showing no signs of failure. To make the most of that intake, a new pumping station was provided and a third pumping engine installed, thus increasing the capacity of the plant to 38,000,000 gallons daily.

Since then, Chicago has, from time to time, added seven more intake tunnels to her water-supply system in order to keep pace with the needs of her steadily growing population. These tunnels extend under the city streets to widely scattered pumping stations, of which there are now eleven in operation with a total daily capacity of 1,650,000,000 gallons. Their output, however, is limited to 1,110,000,000 gallons—the present maximum tunnel capacity.

All but the last two of the tunnels, which are in rock, have been dug through clay and at depths ranging from 30 to 75 feet below the city datum line. Clay, of course, was easier and cheaper to penetrate than rock with the equipment available when the earlier tunnels were driven; and, besides, towering skyscrapers resting on foundations carried down to bedrock had at that time not made their appearance. As a matter of fact, the old Cross Town and Polk Street tunnels have since had to be abandoned because they interfered with building operations on private property.

In plan, the separate intake systems do not differ from the first one begun in 1864—that is, each consists essentially of a crib far



Ewing Galloway, New York

Left—Like all big cities of today, Chicago has its street-traffic problem. Right—Looking north along Michigan Avenue, Chicago's famous "Main Street".

1—Typical section of the 16-foot, unlined water tunnel. 2—Pump room at foot of shaft at the Two Mile Crib. 3—Metal forms in place for lining water tunnel with concrete. 4—Mucking machine at one of the water-tunnel headings. 5—Rock-crushing plant in Chicago water tunnel. This is said to be the first crusher installed under such conditions.

out in the lake, of a shaft in the crib, and of a tunnel leading from the shaft to a pumping station situated either at the lake front or at a point perhaps miles inland. Now the city is and has for some years been at work on an extensive program of water-works development—including pumping stations, a new crib, and tunnels underground and underwater. We shall concern ourselves chiefly with the lake-tunnel end of the project, as it is the most interesting from an engineering point of view.

Chicago Avenue Tunnel, as it is known, is being driven through solid limestone rock and at depths varying from 140 to 200 feet below water level. In short, the bore will be well below the building line; the water supply is not apt to be contaminated by sewage; and the men can work with greater safety because there is less danger of cave-ins. When finished, it will extend from a new crib—that was sunk three miles offshore in 1928—to the foot of Chicago Avenue, and thence west under that thoroughfare for a distance of 7½ miles to the city limits. From this main line—having an inside diameter, unlined, of 16 feet—several branches will run to pumping stations both existing and proposed.

Tunneling underwater is proceeding from two shafts, one close to the waterfront at Chicago Avenue and the other at the Two Mile Crib in Lake Michigan. Several years after this first crib was put in service it became unsafe. To prevent its complete destruction by the buffeting waves it was protected by an encircling breakwater—a gap being left open on the west side so as to permit boats to dock and water to reach the intake. This breakwater is now serving as a foundation for various structures required in connection with the present tunneling operations.

Lake Michigan has an ugly habit of suddenly kicking up a nasty sea that sometimes continues unabated for three or four days running. Under those conditions it is impossible for a tug to get close enough to the crib to land supplies. Therefore, it was necessary to provide suitable accommodations for the men based on the Two Mile Crib. The buildings erected there include not only sleeping quarters, a dining room, a dry house, and a hospital for the workers, but also commodious storerooms, an office, a general repair shop, and a blacksmith shop suitably equipped with a No. 50 drill-steel sharpener, an IRLP shank and bit punch, and a No. 25 oil furnace. All the structures are of steel and tile throughout; and in this choice of building materials the water-works engineers were influenced by a fatal accident in 1909 when a crib, used in the construction of the South Side or 73rd Street Tunnel, caught fire and cost the lives of more than 60 persons. The welfare and the safety of the men, who at the best, must labor under trying conditions, justified the added expense involved in putting up fireproof structures in this case.

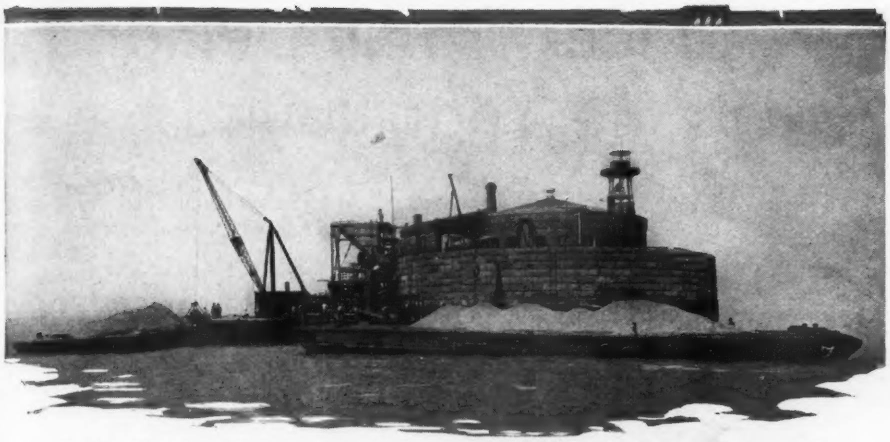
During 1922, the crib shaft was sunk to Elevation —33 through clay, and this material was removed with air-operated diggers. Before the close of that year the buildings and the tunnel power plant were about 85 per cent completed. Pumping in the shaft was done principally with two No. 9 Cameron vertical-plunger sinking pumps. As soon as the excavation reached rock the clay walls were lined with concrete 2 feet thick, giving the shaft an inside diameter of 12 feet. Work on the 14-foot rock section of the shaft was begun on October 17, 1923. It was bottomed at Elevation —204 on November 23, and three days later the heading of the tunnel was turned in at Elevation —185. Until December 6, the men continued to push the heading forward, to drive a short drift westward for storage purposes, and to make a room for pumps. Then operations at that exposed base ceased for the winter, and were not again resumed until March 5, following.

When the tunnel heading was 300 feet in from the opening—that is, when there was no longer danger of flying rock reaching the shaft, a more efficient method of handling the blasted rock and of getting men and supplies up and down the shaft was started. A Thomas elevator hoist, driven by a 100-hp. motor, was installed; and large sheet-metal ventilating ducts, high-pressure air lines for the rock drills, and water pipes were run down the shaft. These are being extended as the work is advanced. Two General Electric 6,000-cubic-foot-per-minute blowers provide ventilating air.

Top—Blacksmith shop, equipped with an Ingersoll-Rand sharpener and an oil furnace, where drill steels are conditioned for driving the water tunnel.
Left—This XB-2 compressor furnishes air for various purposes in the water tunnel.
Right—Near view of two of the numerous Leyner-Ingersoll No. 248 drills at work in the water tunnel.

In the pump room, at the bottom of the shaft, were placed two motor-driven pumps each of which has a capacity of 100,000 gallons a minute. The water is collected in a large sump and emptied into the lake through suitable pipes.

The various drilling, blasting, and mucking operations differ in no way from the present-day methods followed in driving a tunnel through rock. Among the equipment used are two hundred 1-cubic-yard tunnel cars, three 5-ton Baldwin gasoline locomotives, three 6-ton Bloomsburg steam locomotives, six "Little Tugger" air hoists, and many Ingersoll-Rand rock drills, including eighteen No. 248 drifters. The compressor plant consists of a battery of four 16&10x14-inch Type XB-2 machines having a combined capacity of 2,400 cubic feet of free air per minute. These compressors have been in almost continual service on the various municipal tunnel jobs since they were purchased by the city some fourteen years ago.



Carter Harrison Crib. One of the several offshore intakes of the water-supply system of Chicago, Ill.

The tunnel is being lined with concrete; and, in the section under consideration, the blasted rock is utilized as aggregate. The rock is put through a Williams hammer crusher that is capable of supplying 70 tons per hour. The use of such a plant underground is decidedly unusual, but in this case it not only helps to dispose of much of the excavated material but it also obviates towing aggregate from the shore to the working site.

From 30 miles of distributing mains to an aggregate of 70 miles of lake tunnels and a network of 3,400 miles of distributing mains in 75 years may well be considered a great achievement in municipal water-works engineering. Such is the record Chicago has to her credit: and, when the work now in hand is completed, the system will rank second to none the world over.

The modernizing and expanding of Chicago's water-supply system is being carried forward under the general direction of Richard W. Wolfe, commissioner of public works, and of Loran D. Gayton, city engineer. The actual operations are supervised by James J. Verslius, chief engineer, with the aid of A. G. Anderson and George D. Thompkins, assistant engineers.

EXTRACTING VALUES FROM THE McMURRAY TAR SANDS

AN experimental plant for the mechanical separation of oil, gasoline, and asphalt from the McMurray tar sands is now going up on the outskirts of Edmonton, Alberta. This plant will treat 150 tons daily, and is but the initial step in an industry that promises to be of big proportions. If the extraction process soon to be tried out there on a small but commercial scale is a success, then the development of the bituminous-sand deposits of the McMurray district is assured. The deposits are known to contain an enormous supply of oil—enough, so it has been said, to satisfy the world demand for many years.

During 1929, the consumption of steel ingots in the United States reached the unprecedented figure of approximately 1,000 pounds per person. This is an increase of 70 pounds over the preceding year, or more than three times the per capita demand in 1900.

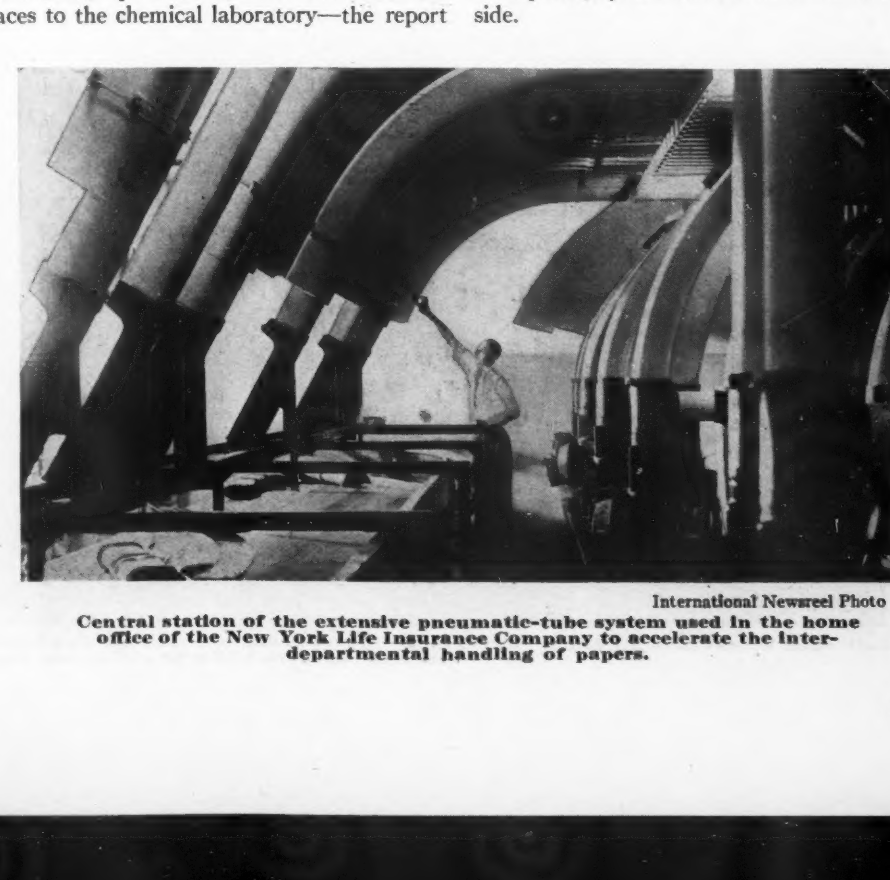
PNEUMATIC TUBES AS AN AID IN DISPATCHING BUSINESS

LARGE business houses and industrial establishments, covering many square feet of ground or floor space, are depending more and more upon pneumatic-tube systems to facilitate the interdepartmental delivery of considerable volumes of matter that must pass from hand to hand in the run of an ordinary day's work. The pneumatic tube, as such, is nothing new; but the services it is performing in speeding up paper work and plant production are of interest and open up a wide field of possible application.

Newspaper offices, insurance companies, banks, hotels, hospitals, railroad freight-classification yards, etc., now make extensive use of this form of dependable and quick messenger service; and they consider it as indispensable as the telephone in the discharge of business. However, papers are not the only things handled by pneumatic tubes. They are being variously installed in dye houses, paint factories, steel mills, etc., to carry samples between laboratories and production departments. In steel mills, for example, they have greatly simplified the delivery of hot specimens from blast, open-hearth, and bessemer furnaces to the chemical laboratory—the report on the analysis of each test piece, which may weigh from 1 to 3 pounds, being rushed back to the department concerned in the same fashion. Considering that the bessemer furnace alone, in the case of a certain plant, sends on an average of 300 such hot specimens daily to its chemical laboratory, we can appreciate just how the pneumatic tube is helping to speed up output.

With the exception of the size of the tubes and the design of the carriers, themselves, these different systems are substantially like those that have been employed for years for carrying cash in department stores and for the dispatch of mail matter. Carriers are now made to meet all sorts of special requirements, and range all the way from tubes 1¼ inches in diameter for the handling of radio messages, telegrams, and telephone toll tickets to oval tubes 4x7 inches in cross section for holding complete folios of correspondence, insurance policies, and the like. In between these two sizes are 2¼-inch tubes for general message and utility service; 3-inch tubes for tools and small machine parts; 4-inch tubes for ingot samples and gunpowder; 5-inch tubes for testing laboratories and railroad freight-classification yards; and 3x6-inch oval tubes for banks and publishing houses. Many more applications could be cited, but these will suffice to give an idea of the diversified present-day uses to which pneumatic tubes are being put.

The preliminary survey of the Strait of Gibraltar Tunnel project, which is now well in hand, calls for a test boring 2 feet in diameter in the neighborhood of Tarifa, on the Spanish side, and for the thorough exploring of the ocean bed between the projected terminals. At the beginning of the year, the hole was 328 feet down—just about one-fifth the total depth to which it will have to be carried in order to reach the proposed tunnel line. As planned, the tunnel will be driven 325 feet below the bottom of the Strait. A similar exploratory hole will be sunk on the African side.



International Newsreel Photo

Central station of the extensive pneumatic-tube system used in the home office of the New York Life Insurance Company to accelerate the interdepartmental handling of papers.

Special Snow Plows Meet Traffic Demand For Open Roads the Year Round

OPEN roads both winter and summer are a social and economic necessity in this day of improved highways and of heavy motor traffic. Time was when people put up their automobiles for the winter and when motor trucks and buses were not used as extensively as they are now at that season in the transportation of passengers and commodities of all kinds. But conditions have changed, and today there are almost as many cars on the road in winter as during the rest of the year.

This plow has demonstrated its capacity to clear a path of snow at the rate of from 30 to 75 cubic yards a minute, depending upon the water content.

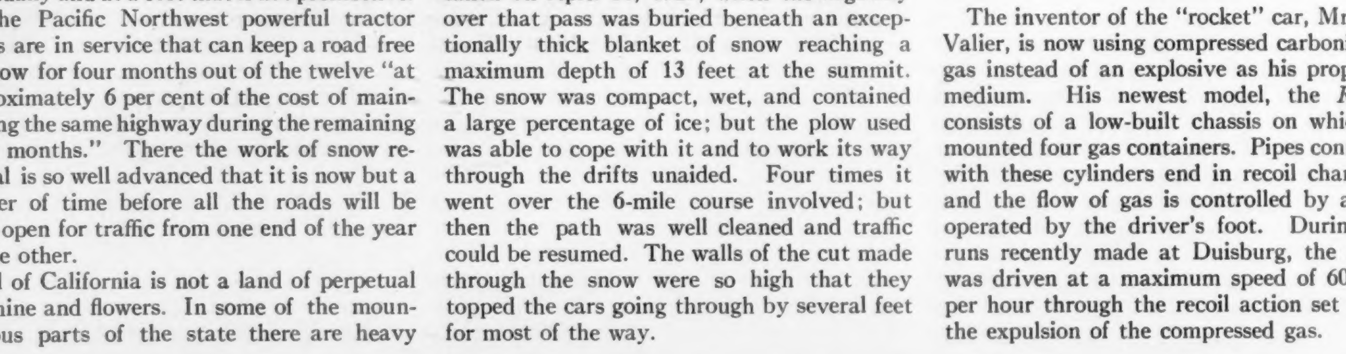
Highway departments have been forced to recognize this fact and to meet the demands imposed by providing equipment that make it possible to keep at least the main arteries of traffic clear at all times. This has represented somewhat of a problem, especially in our northernmost states where the winters are long and severe and where snow anywhere from a few inches to 12 feet and more in thickness may have to be removed. This, we are told, is now being done effectually and at a cost that is not prohibitive. In the Pacific Northwest powerful tractor plows are in service that can keep a road free of snow for four months out of the twelve "at approximately 6 per cent of the cost of maintaining the same highway during the remaining eight months." There the work of snow removal is so well advanced that it is now but a matter of time before all the roads will be kept open for traffic from one end of the year to the other.

All of California is not a land of perpetual sunshine and flowers. In some of the mountainous parts of the state there are heavy snowfalls, as the accompanying scenes along Domer Pass make plain. The pictures were taken on April 28, 1929, when the highway over that pass was buried beneath an exceptionally thick blanket of snow reaching a maximum depth of 13 feet at the summit. The snow was compact, wet, and contained a large percentage of ice; but the plow used was able to cope with it and to work its way through the drifts unaided. Four times it went over the 6-mile course involved; but then the path was well cleaned and traffic could be resumed. The walls of the cut made through the snow were so high that they topped the cars going through by several feet for most of the way.

The machine that did this job is of a new type, and is said to be able to handle snow of any depth with equal facility. It can pick up and deliver clear of the right of way in the course of a minute about 30 cubic yards of hard-packed snow or from 50 to 75 cubic yards of newly fallen snow, depending upon the water content.

The Wright plow is secured to a caterpillar tractor and so hinged to it that the plow can be moved up and down by power-driven hydraulic jacks. When employed to dispose of snow of moderate depth it does so quickly and with ease—the mass first being broken up by oppositely revolving cutter blades before reaching a propeller that throws it out and to either side of the roadway. Where deep snow is encountered, as in he case of Domer Pass, the caterpillar plow climbs right up on top of it and removes it in layers by traveling back and forth over the same ground until it is cleared.

The inventor of the "rocket" car, Mr. Max Valier, is now using compressed carbonic-acid gas instead of an explosive as his propulsive medium. His newest model, the *Rak 5*, consists of a low-built chassis on which are mounted four gas containers. Pipes connected with these cylinders end in recoil chambers; and the flow of gas is controlled by a lever operated by the driver's foot. During test runs recently made at Duisburg, the *Rak 5* was driven at a maximum speed of 60 miles per hour through the recoil action set up by the expulsion of the compressed gas.



Left—The Wright plow digging its way through 10 feet of snow on an April day in sunny California. Right—A section of Domer Pass after the plow had gone over it four times.

Historic Industry Revitalized by Research

Sugar-Cane Culture in Louisiana Has Been Saved from Ruin Through the Prompt Action of Government Experts

By R. G. SKERRETT

A ROMANCE of Agricultural Research! Such, indeed, would be a fitting description of work recently done that bids fair before long to fill "Louisiana's Sugar Bowl" to overflowing. Through the joint efforts of scientists and associate groups of public-spirited citizens, the ebbing tide of a historic industry has been turned into a flood tide of amazing promise.

Experts of the United States Department of Agriculture have led in the painstaking investigations that have revealed how Louisiana's endangered cane-sugar industry could be revitalized and made far more productive than it ever was in the days of its prime. One particularly harmful plant disease had virtually affected every stand of sugar cane in the State; and from an output of 352,874 tons in 1911, production had fallen in 1926 to the disheartening minimum of 47,000 tons of raw sugar—the lowest figure reached during the preceding half a century.

The Government agricultural scientists determined the nature of the disease and discovered that the malady was spread by a tiny insect carrier. After long search in foreign lands they succeeded in finding strains of sugar cane especially resistant to the disease in question and they have also succeeded in developing other resistant strains by breeding. A further reward of their labors was canes that can reach their maturity within a wider climatic range than was possible with the canes formerly planted in the region. These achievements add potentially many, many millions of dollars annually to the wealth that can be garnered from far-flung sections of the South; and it is easy to understand why the people of Louisiana, in particular, are now rejoicing.

To evaluate what has been accomplished in this special field of agricultural research we must know something about the past of sugar-cane growing in Louisiana and the way in which the industry expanded there until it became the State's outstanding source of agricultural wealth and an example for a long while to the whole world of the systematized production of cane sugar. Indeed, for many years Louisiana furnished most of the sugar used in this country. Of course, that was before our per capita consumption had reached anything like its present proportions of more than 105 pounds annually.

Within a few years after Columbus discovered the West Indies, sugar cane was carried to the Island of Santo Domingo and planted there; and it is a matter of record that there were numerous sugar mills operating on that island in 1518. Sugar cane was first cultivated in continental America in 1751, when cuttings imported by Jesuit priests were planted in the rich delta soil of Louisiana. Even so, sugar cane for some time afterwards was grown only on a small scale and in scattered places. Necessity—economic necessity—brought about wider interest in sugar cane.

Near the close of the eighteenth century, the failure of certain established crops—among them indigo—compelled the planters of Louisiana to look for some other source of revenue from their lands, and then it was that they turned to the cultivation of sugar cane in the crisis confronting them. In 1795, the first successful sugar mill began to operate on a plantation a few miles north of New Orleans; and America's cane-sugar industry may properly be said to date from that time. Sugar-growing was favored by climate, soil, and abundant and low-priced labor; and plantation after plantation took up the cultivation of cane. Consequently, new mills were erected in increasing numbers to handle the cane and to turn out sugar. The story of the industry is one of well-nigh continuous expansion for substantially a hundred years—the peak of production being reached about 1894.

Doctor Brandes inspecting sugar canes growing in a greenhouse at the Arlington Farm of the United States Department of Agriculture. He is handling one of the disease-resistant sugar canes obtained in New Guinea.

From 1894 to 1911 production was maintained generally at the peak attained in 1894, but a climax was reached in 1911 when the quantity of sugar manufactured totaled 352,874 short tons. From that day onward there was a gradual reduction in the acreage planted to sugar cane and a marked decrease in the yield of sugar per acre of cane. The situation at the close of 1926—the last season in which the State's production of sugar was made from certain long used varieties of cane—was a desperate one; and, on the face of it, Louisiana's historic cane-sugar industry seemed doomed. Mosaic disease was rampant, and the fields yielded but 6.7 tons of cane per acre!

Happily, the Government experts were alive to circumstances that had been commonly overlooked by the sugar planters of Louisiana; and seven years previously Dr. E. W. Brandes, principal pathologist in charge of the office of sugar plants of the United States Department of Agriculture, had broadcasted a warning that the mosaic disease menaced the entire sugar industry of the State. His warning fell for the most part on deaf ears, because the cane crops, as far as they went, seemed to be fairly good, and at that time the planters were mostly unfamiliar with the outward evidences of the disease. To them a lack of robustness and a reduction in the sizes of the cane were not, in themselves, alarmingly significant. In short, they could not read

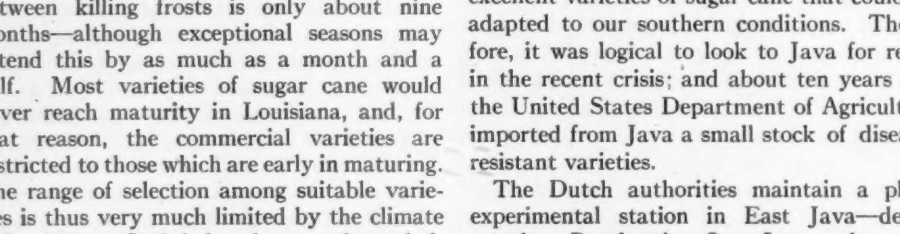
the signs with the understanding eye of the pathologist.

Some one will ask: "What is the mosaic disease; how does it affect the cane; and how can it be combated?" The mosaic disease causes a mottled appearance of the leaves due to the destruction of the green coloring matter in them. In consequence, there is a stunting of the plant because of the impairment of that wonder-working chemical that reacts to the beneficent rays of the sun. The virus of this wasting plant malady is carried from diseased to healthy plants by an insect; and the problem of the plant pathologist has been to discover either ways of dealing with the carriers or to find varieties of sugar canes that have become immune or relatively tolerant to the disease by natural processes. Such being the situation, let us see how the Government experts anticipated Louisiana's needs and laid the foundation for the rehabilitation of her cane-sugar industry. To understand what they did we must realize some of the handicaps imposed upon sugar-cane cultivation in our South.

A luxuriant stand of "POJ 213" sugar cane growing in Louisiana. This is one of the disease-resistant hybrid canes obtained from the Dutch Government's experimental station in East Java.

Normally, sugar cane belongs to the tropics, because there it can complete its ordered cycle and reach a stage of full maturity. Therefore, sugar cane grown in the United States is actually cultivated beyond its natural climatic zone; and, in consequence, is just that much more sensitive to climatic conditions. In Louisiana, for example, the average period between killing frosts is only about nine months—although exceptional seasons may extend this by as much as a month and a half. Most varieties of sugar cane would never reach maturity in Louisiana, and, for that reason, the commercial varieties are restricted to those which are early in maturing. The range of selection among suitable varieties is thus very much limited by the climate of Louisiana. Such being the case, the pathologists of the United States Department of Agriculture turned to other countries in their search for disease-resistant varieties, hoping to find among the thousands in existence some that would combine the qualities of resistance and earliness. Quite a hundred years previously, Louisiana had obtained from Java excellent varieties of sugar cane that could be adapted to our southern conditions. Therefore, it was logical to look to Java for relief in the recent crisis; and about ten years ago the United States Department of Agriculture imported from Java a small stock of disease-resistant varieties.

The Dutch authorities maintain a plant experimental station in East Java—designated as Proefstation Oost Java—where Dr. Jan Kobus had developed canes capable of withstanding the Sereh disease. In that important work, Doctor Kobus went far afield for some of his stock. In fact, he drew upon canes that have flourished for centuries on the slopes of the Himalayas and which, by a process of the survival of the fittest, have become able to resist disease and to stand a good deal of cold. The Himalayan cane is slim in form; contains a nearly negligible measure of sugar; and is, therefore, the very opposite of the plump or "noble" sugar-bearing cane utilized generally by commercial growers. Doctor Kobus crossed that rugged and small cane with Louisiana cane of a high sugar-bearing character. The canes so brought into being—now known as the *POJ* varieties—proved to be disease resistant, to be rich in sugar, and more rugged than those formerly planted in Louisiana. Curiously, the sugar content of the hybrids was greater than that of the plump canes, and, what was of more importance, it was discovered that these canes are endowed with a measure of resistance to both mosaic and Sereh disease.



The Fairchild flying machine as it appeared at Bolling Field, Washington, D. C., before it was sent to New Guinea for service with the sugar expedition of the United States Department of Agriculture.

The canes imported from Java were planted under glass on the Government experimental farm at Arlington, Va., and there propagated for observation by the critical experts of the Office of Sugar Plants. The authorities could not afford to issue the new canes to any of the Louisiana planters before investigation justified such a course. Nothing would be gained by releasing canes that were no better than those already suffering from disease; and there was, besides, the possibility that some of the Javanese hybrids might even be less suitable for commercial use in the South. Doctor Brandes and his associates were purposely deliberate; and after testing the new canes for a couple of years one of them was released in the spring of 1922 to the enterprising general field manager of the well-known Southdown Plantation in Louisiana. Mr. Elliot Jones, the field manager, received from Washington a few eyes of the variety designated as *POJ 234*—a cross between Louisiana cane and Indian cane from the Himalayas.

Greenhouses at Arlington Farm where many kinds of sugar canes are growing in the Government's quest for types resistant to cold and disease but capable of yielding high percentages of sugar.

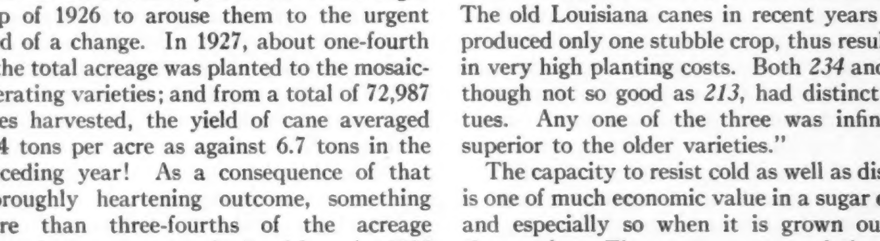
Mr. Jones knew that the sugar industry in Louisiana was in an extremely bad way. He recognized that the canes from Java were not the big, soft canes long familiar to him; but, unpromising as *POJ 234* looked, he was, nevertheless, anxious to give it a chance to prove its worth on the soil of Southdown. Even so, circumstances were seemingly bent upon blocking his forlorn hope. Out of the shipment of cane dispatched from Washington only 21 eyes succeeded in germinating; and then the cane borer got busy and did its best to block a venture that meant everything in revitalizing a rapidly dying industry. However, sufficient of the shoots of the new cane survived at the end of the first season to warrant hope—the results of the test being in all respects encouraging. In 1923, the Department of Agriculture released to the Southdown Plantation two more of Doctor Kobus' hybrids—*POJ 36* and *POJ 213*.

Before the close of 1924, there were on the Southdown Plantation four acres of *POJ 234* and a short row each of *POJ 36* and *POJ 213*. All three canes showed themselves highly resistant to the mosaic disease, and they gave excellent yields while growing under identical conditions with neighboring canes of the old varieties—canes that produced scarcely any stalks fit for seed purposes. At that time, the stands of Java canes on the Southdown Plantation represented substantially 98 per cent of those much needed canes then available in the United States. The Southdown Plantation, through gift and sale at a nominal cost, made it possible for the Department of Agriculture and the American Sugar Cane League to distribute seed cane to scores of planters who were hard pressed because of the crop failure of much of their sugar cane. The Southdown Plantation did this generous thing to promote coöperation and to stimulate further experimental work on the part of the Federal and the State agricultural departments.

Farmers as a class are conservative. The majority of the sugar planters in Louisiana were frankly skeptical of the claims made for the new canes; and they unhappily had to have the disastrous object lesson of the sugar crop of 1926 to arouse them to the urgent need of a change. In 1927, about one-fourth of the total acreage was planted to the mosaic-tolerating varieties; and from a total of 72,987 acres harvested, the yield of cane averaged 13.4 tons per acre as against 6.7 tons in the preceding year! As a consequence of that thoroughly heartening outcome, something more than three-fourths of the acreage planted to sugar cane in Louisiana in 1928 was of the disease-resisting strains. Individual plantations reported exceptionally high yields from fields cut for seed at the beginning of the grinding season. From stands of *POJ 213* one planter obtained an average of 37 tons of cane per acre, and another realized as much as 46 tons per acre from *POJ 36* cane! In other words, the 1928 crop was counted upon to make a return of $21,000,000 as against the $7,000,000 realized from the 1926 crop harvested from a considerably greater acreage. Surely the tide had changed, and Louisiana could with reason look forward to the restoration of an industry capable of adding $100,000,000 to the wealth of the South.

Mr. D. W. Pipes, Jr., president of the American Sugar Cane League, is thus quoted by *The Executive's Magazine:* "In 1925, the American Sugar Cane League sold the resulting seed cane at $110 a ton. The League is entirely a coöperative body made up of planters and business firms interested in sugar. The proceeds from the sale were about $30,000, and a Federal field laboratory was erected at a cost of approximately $7,500. Southdown, by this time, had a large acreage of *234* and fifty acres each of *213* and *36*. The characteristics of the three varieties had now become very plain. *POJ 213* appeared as the best all-around cane for Louisiana, being highly resistant to cold and to mosaic disease, and producing at least two stubble crops. I mean by this that it is not necessary to plant sugar cane every year. It will come up from the stubble or roots of the former crop. The old Louisiana canes in recent years had produced only one stubble crop, thus resulting in very high planting costs. Both *234* and *36*, though not so good as *213*, had distinct virtues. Any one of the three was infinitely superior to the older varieties."

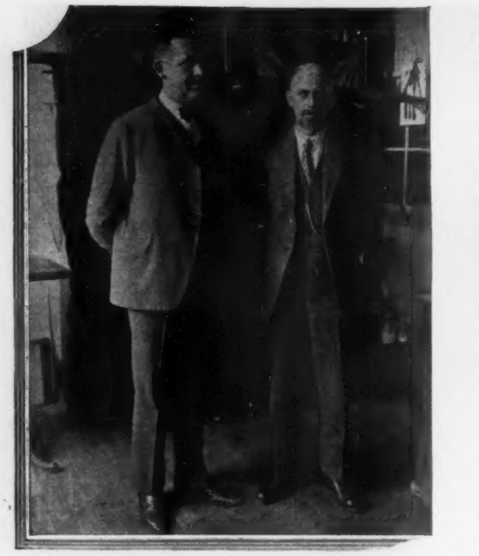
The capacity to resist cold as well as disease is one of much economic value in a sugar cane, and especially so when it is grown outside the tropics. The sugar content of the cane increases rapidly during the late fall season;



After reaching the tropics the sugar expedition's airplane was fitted with pontoons so that it could alight on water. This picture was taken on a river in New Guinea at a point 260 miles from the coast.

and for that reason the cane is left standing until the planters are warned of the approach of possibly damaging temperatures. When a cold-wave warning reaches them, then every available man is set to work windrowing—that is, cutting and covering—the cane; and in the course of 24 hours hundreds of thousands of dollars worth of cane may be cut and protected from oncoming frost. Now we know, in part, why one of the parent stocks of the new canes was sought for in the Himalayas—unpromising as that variety would ordinarily seem to the sugar grower.

Once the scientific mind is directed into a given channel it becomes tireless as long as it believes further attainment possible. It was this urge that carried Doctor Brandes again to the Orient in 1928. In April of that year, accompanied by Dr. Jakob Jesweit, of Holland, and by a member of the Hawaiian Sugar Planters' Association, Doctor Brandes visited New Guinea, the reputed home of the original sugar cane, and penetrated into the interior of that country a distance of 260 miles from the coast. There the party searched for wild varieties of sugar cane, and obtained more than 150 new strains. These were carried back to Washington for experimentation and to undergo a full year's quarantine to make sure that they would not introduce any disease.



Left—Dr. E. W. Brandes, principal pathologist, in charge of the office of sugar plants, United States Department of Agriculture. Right—Dr. Jakob Jesweit, of the University of Wageningen, Holland, who was associated in the work done by the sugar expedition.

New Guinea or Papua is the habitat of pigmies and head hunters, and explorers venturing into the wilderness of that tropical region ordinarily expose themselves to sudden hazards. Doctor Brandes wisely employed Papuan natives to assist him in collecting the sugar canes he sought and also to promote friendly intercourse with the primitive peoples in the interior. As a means of facilitating transit to the heart of that tropical region, Doctor Brandes utilized a seaplane built in the United States. That flying machine served him admirably in attaining his goal by following watercourses upon which he could alight from time to time in order to make camp or to get into sections where the wild canes of his quest flourish.

The Department of Agriculture now has at its disposal in the South experimental stations that were not available to it prior to the beginning of the research work that has already done so much for the cane-sugar industry of Louisiana. At these stations the canes brought back from New Guinea in 1928 will undergo painstaking scientific investigation; and only such of them will be released for commercial culture as demonstrate their fitness for that purpose. Incidentally, hybridizing under glass will go forward in a search for strains that may prove to be even superior to the famous *POJ* varieties for planting in the South.

It is highly likely that strains of sugar cane may thus be brought into being that will make it entirely practicable to grow cane for sugar-making throughout a far more expansive area in the South than has heretofore been feasible or wise. Furthermore, such canes will enable farmers in a still more extensive belt of the South to grow sugar cane for syrup-making. One has only to look at the present statistics dealing with the manufacture of molasses and cane-sugar syrup to visualize the possibilities of such a broadening of the territorial limits within which sugar cane can be cultivated profitably on a commercial scale.

For many years, the fibrous refuse of the crushed sugar cane was a troublesome by-product of the cane-sugar industry. While much of it was utilized at the centrals for fuel, still a great deal of it remained to be got rid of. Inventive genius finally discovered that bagasse, as the waste is called, could be employed in making a very desirable form of wallboard fit for many services. As a result, an industry of considerable proportions has developed; and its continuation and expansion are intimately identified with the survival of sugar-cane culture in the South.

The dramatic significance of the survival of the first of the *POJ* sugar-cane eyes, planted on the Southdown Plantation in 1922, should now be plain to us; and it is possible for us to comprehend the economic potentialities of the work done by Doctors Kobus and Brandes and their collaborators. Through their labors an impending tragedy has been transformed into a triumph—all because of agricultural research that truly savors of the romantic.

Photos, U. S. Dept. of Agriculture.

These Papuan natives assisted the sugar expedition in collecting "wild" sugar canes in New Guinea.

SEALING REGENERATOR CHAMBERS AGAINST GAS LEAKAGE

THE following facts from the *Iron Age* are interesting, relating, as they do, to the satisfactory insulating of regenerator chambers of open-hearth furnaces To prevent air infiltration and, at the same time, gas leakage through the joints of the brickwork of a large furnace in the Ruhrort-Meiderich Steel Works, in Germany, the walls were lined with steel plates to a point 20 feet down from the top. This was only a partway solution, however, as the gases forced their way through the joints in the walls and the casing and escaped where the plates terminated. Little was accomplished by filling the holes and interstices with mortar

It was then decided to do some research work with an experimental chamber. This chamber was finally effectually sealed by putting "Aerodensit" between the bricks. This plastic material permits the brick walls to expand and to contract without breaking or cracking the joints. It is said to be inexpensive and easy to apply. The plant which made the tests is planning to use "Aerodensit" between the joints and over the brickwork generally and to do away with the steel-plate lining. This is an advantage, as it leaves the brick walls of the regenerator chambers exposed for ready inspection.

Wonders Wrought by Metal Bellows

Story of an Amazing Industry That Has Grown Out of Curiosity About Thunderstorms

By A. S. TAYLOR

A typical Sylphon bellows made from a single piece of metal. A unit like this constitutes the heart of all Sylphon automatic control apparatus.

GUESSING what the next day's weather would be!

Trying to satisfy a critical public; and having to do this with instrumental aids that were much more limited 30 years ago than they are now. Such was Weston M. Fulton's job when serving as the local forecaster in the Knoxville office of the United States Weather Bureau back in the late "nineties".

Knowing how captious the public becomes when the weather turns out to be the opposite of that officially prophesied, we can readily imagine that young Mr. Fulton had enough to disquiet him normally without going afield to add to his troubles; and yet that is exactly what he did when the urge of scientific curiosity possessed him.

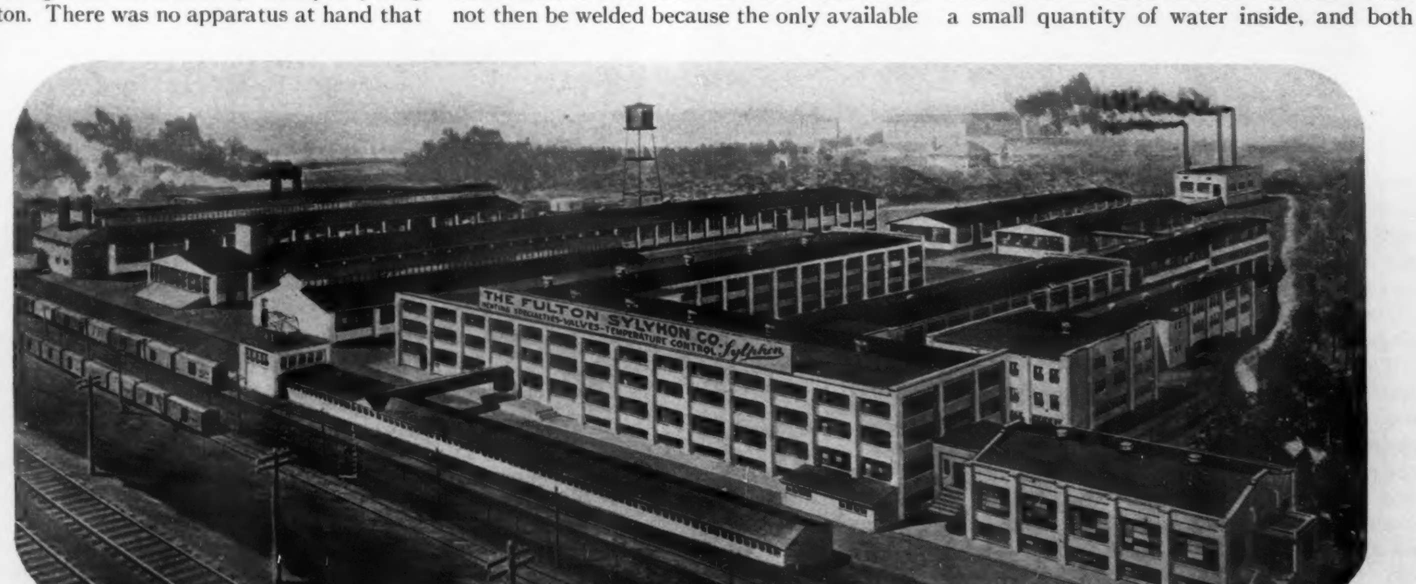
History does not record that Knoxville enjoyed a considerable spell of fair weather just at that particular period of 1899, but we assume such to have been the case, for otherwise how could Mr. Fulton have found time to relax and to give himself over to pleasurable speculation about the degree of expansion that takes place in the atmosphere when the sky is pierced by a flash of lightning? Most of us would be content with the simple knowledge that the heat of such an electrical discharge would inevitably cause the air to expand, and let the problem, if so considered, rest there. But W. M. Fulton was and is different; and from that point on for a considerable interval there was a good deal of unrest for both that gentleman and his family.

How to make the measurement desired was the thing that momentarily stumped young Fulton. There was no apparatus at hand that would serve for such an experiment. It was plain to him that he would have to construct special equipment — something in the form of an expansible container filled with moist air, through which he could pass an electric spark. In short, he had to fashion a metal vessel within which he could reproduce the phenomena of a thunderstorm in miniature. The task proved far from a simple one; and weeks passed before success was won in the woodshed, back of the Fulton home, that served as an improvised laboratory.

The inventor missed a good many of his meals before he was able to model a flexible strip of metal into a small cylindrical bellows possessing a notable degree of resilience. We just naturally wonder what happened to the weather in that bustling Tennessee city in the meanwhile! We know something about the inventive mind when wholly engrossed with a fascinating problem. Before that bellows was shaped it was necessary to make special tools to do some of the work, and then the burden of completion depended upon Weston Fulton's facile fingers. In the end, accomplishment proved to be just a milestone on a road beset with numerous obstacles.

To begin with, the bellows had a single, soldered, lengthwise seam that soon opened up when the contraption was repeatedly compressed and distended. To make the situation worse, the thin steel of the bellows could not then be welded because the only available process caused weakening corrosion. Sheet brass could not be used because a satisfactory union could not be made at the seam. "W.M." was halted but not dismayed; and in the moment not devoted to weather forecasting he racked his brain for another way to accomplish his purpose. Just about that time young Fulton lost interest in thunderstorm research· he turned his back on the realm of science and envisioned the dominion of commerce—picturing the practical rewards that might flow from a self-winding clock actuated by the solar expansion of one of his metal bellows. The idea appealed to him just as it would to millions of others that have to wind clocks ever so often.

Once more the woodshed laboratory held him whenever he could get away from the burdensome duty of making weather guesses. With infinite patience and no end of labor he produced an arrangement of dies that could transform a strip of sheet brass into a thin-walled, seamless tube and then turn that smooth tube into a cylindrical bellows that could be flexed much after the fashion of an accordion. That was, indeed, an achievement; and the solar clock seemed assured. With a small quantity of water inside, and both



Present expansive plant in which the Fulton Sylphon Company makes its various interesting products.

ends sealed, the bellows could be elongated by applying sufficient heat to cause some of the contained water to vaporize. "W. M." counted upon the sun to provide the needful heat; and his idea was to utilize the expansion of the bellows to operate the winder of his clock.

Only one timepiece was so equipped, and then the inventor was started off on another tack by the suggestion of a steamfitter called in to make some domestic repairs. The pipefitter was duly impressed with the way Fulton's metal bellows functioned; and he prophesied a fortune for the inventor if the contrivance could be adapted so as to regulate the dampers of steam-heating boilers. As matters turned out that mechanic was a first-rate forecaster—the United States Weather Bureau could have used him to advantage. Let it be recalled that back about 1900, the regulators generally used on steam-heating boilers depended upon the action of rubber diaphragms; and those members soon hardened, necessitated continual adjustment, and commonly lasted but a single season.

The idea of ready money and plenty of it appealed to the Government weatherman whose salary at the time was well within that range usually termed "modest". Apart from the monetary urge, the mechanic's suggestion had an inspirational value inasmuch as it opened to young Fulton a vista of many useful applications of his hard-wrought apparatus. Once more "W. M." had new ground to break before he could plant and harvest. It was plain to him that his bellows would have to expand more sensitively than when depending upon the vaporizing of water by heat. He realized that he would have to employ a liquid with a boiling point far below that of water.

After some hunting, he hit upon a liquid that boils at a temperature of about 95° F. He put a measured quantity of this in his little metal bellows and then sealed that vessel so that the vaporizing of that fluid by heat would elongate the bellows—the extent of this movement depending upon the degree of heat and the period of its application. This contrivance he attached to a steam-heating boiler in such a way that the bellows would expand and close the draft when the steam pressure rose to a given point. With the draft closed, the fire in the furnace subsided accordingly and the boiler pressure dropped proportionately. When the boiler cooled sufficiently, the bellows reacted like an extended spring and opened the draft so as to restimulate the fire and gradually to raise the boiler pressure enough to send steam once more through the pipes and radiators of the heating system.

It is a matter of record that Fulton's automatic damper control worked so surely and so well that a large company, engaged in the manufacture of steam-heating equipment, contracted with Fulton to take all the seamless metal bellows he could produce during the succeeding period of ten years. Such was the modest outlook when the original plant for the manufacture of Sylphon bellows was organized in 1904. Since then, that factory has been completely overshadowed by an aggregation of up-to-date buildings in which are done the manifold things needful in producing Fulton Sylphon seamless metal bellows. Indeed, the present forge shop is twenty times as big as the whole of the original plant; and the forge shop, by the way, is but one of numerous associate structures.

When Mr. Fulton devised his metal bellows for damper regulation he had the genius to originate a new way to apply the age-old principle of the lever; and his pioneership in that work has been confirmed by the courts in disposing of those bent upon imitation. Because the apparatus utilizes this fundamental principle it has lent itself to hundreds of service adaptations; and today Sylphon bellows are being turned out in more than thirty sizes so that they can perform their helpful functions in many fields of use Most of these call for the regulation of temperature, pressure, or vacuum; but a few of them depart somewhat from this general classification. The majority of us are quite unaware of the services so performed directly or indirectly for our comfort, convenience, or well-being; and it would not be out of place at this point to outline some of the things Sylphon bellows do.

Before describing the uses to which Sylphon regulators are put, let us repeat for the sake of emphasis that the Sylphon bellows is the very heart of the various apparatus manufactured by The Fulton Sylphon Company; and each bellows contains a prescribed and suitable quantity of a highly volatile liquid

1—After Sylphon thermostats are assembled they are tested in small tanks with air at a pressure of 125 pounds in order to discover leaks. 2—All Sylphon damper and temperature regulators are painted with an air brush. 3—In this department, where Sylphon bellows are fitted with heads, etc., the lathes are equipped with air-operated chucks.

1—The battery of powerful presses that make tubes of various sizes from flat strips of special brass. These tubes are afterwards rolled into Sylphon bellows. 2—Close-up of one of the presses used in forming large Sylphon tubes. Compressed air blows the tubes from the piston or plunger of the press. 3—Sylphon tubes are dipped in a hot cleaning solution to remove dirt and scale. The metal baskets containing the tubes are raised and lowered by cylindrical air hoists. 4—This machine stamps small thermostat parts from sheet brass, and these are blown from the die with compressed air. 5—A section of the forging department where small brass parts are made for thermostats. Compressed air sprays the oil used for fuel in the furnace and for heating the dies in the press before beginning operations.

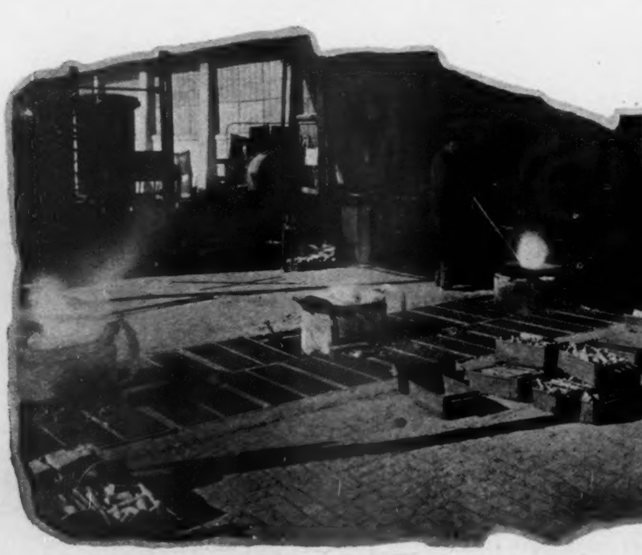
Left—All small thermostat parts that require machining are made in this department. The turret lathe seen here is equipped with an automatic air chuck. Right—Each lathe is provided with an air chuck for holding valve and thermostat parts while being machined.

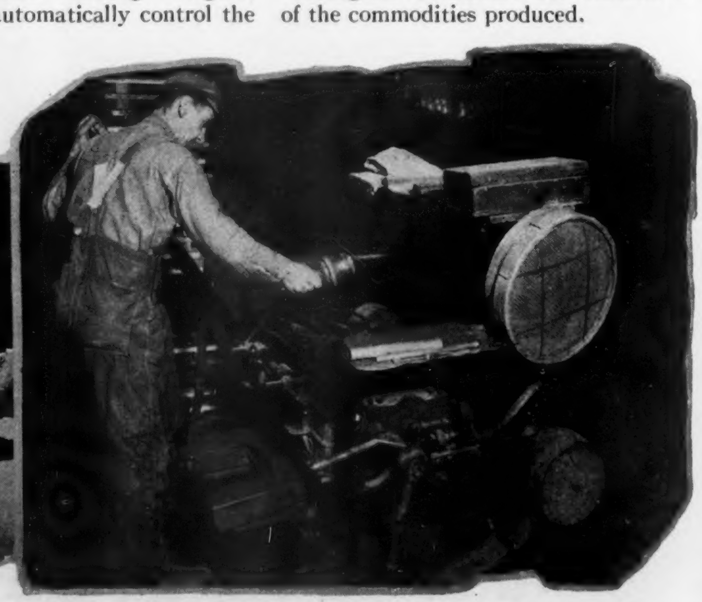
that is extremely sensitive to temperature changes. In fact the company's chemists have found it possible to compound liquids which will vaporize in the bellows at any temperature ranging from one degree up. When any one of these liquids vaporizes it creates within the bellows a tremendous pressure, and this causes the bellows to distend and to exert force upon a mechanical member designed to operate a valve, a damper, or some other essential control feature. Conversely, when the volatile liquid cools and reliquifies, no internal pressure is exerted, and the bellows contracts by reason of the resilience due to its corrugated form. In contracting, the bellows reverses the control movement exercised when expanding, and opens, closes, or shifts something agreeably to the immediate service for which it is provided. It does not call for a great deal of imagination to picture at least some of the ways in which this ingenious but simple invention can perform.

Sylphon temperature regulators for liquids are used extensively in dye houses, where proper results can be assured only by making certain that the liquid dyes shall be held within suitable temperature ranges for the textiles or fibers being treated. That is to say, cotton, wool, silk, and rayon all have distinctive critical temperatures; and the dyeing solutions must not be above these lest the materials become discolored and perhaps lose luster and strength. Again, uniformity of temperature is required in the after treatments following dyeing; and the same is true during mercerizing and the steps subsequent to that process. Manifestly, the function of the Sylphon regulator touches us closely when it has to do with the things with which we garb ourselves.

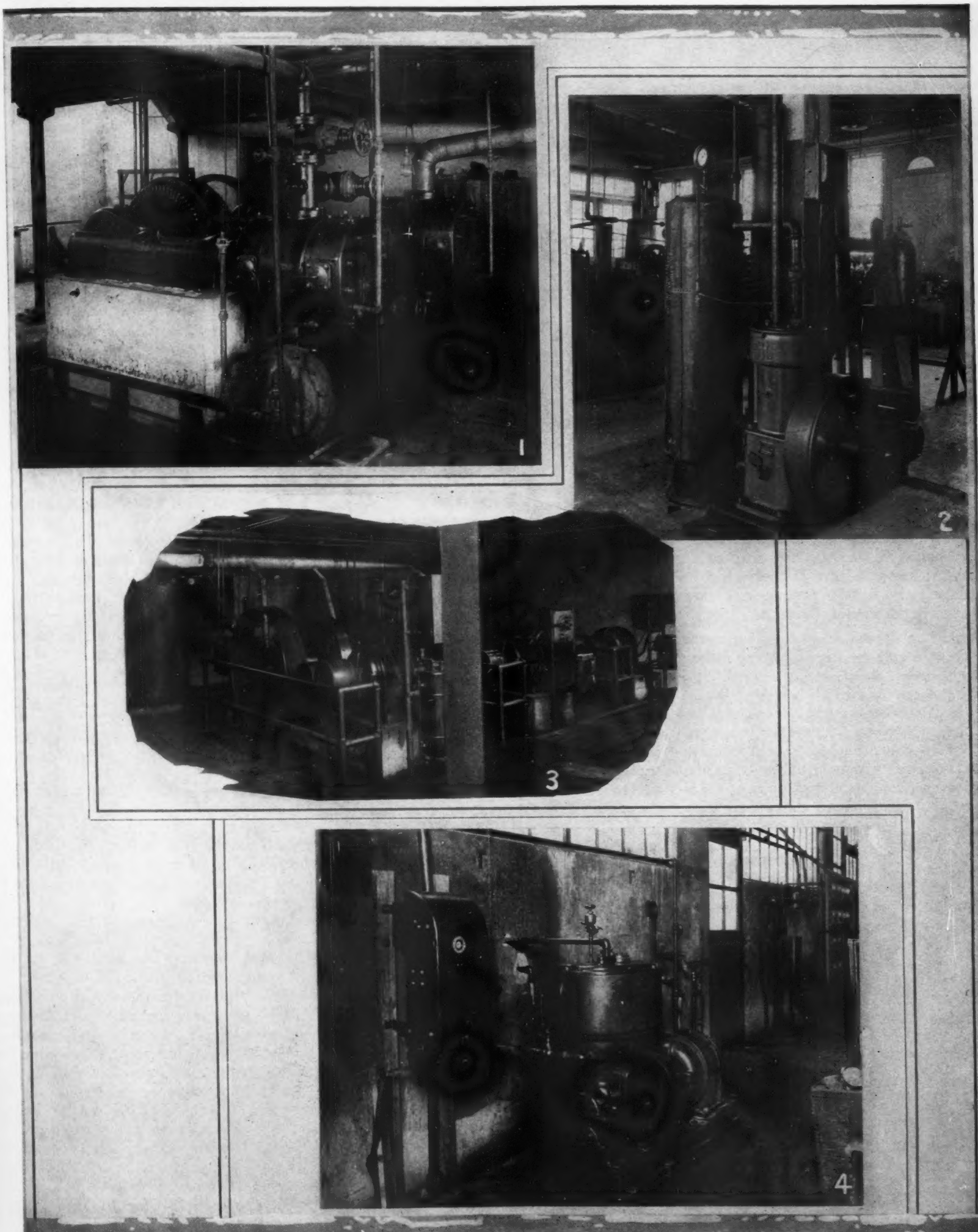
Much of the food prepared for the multitude in restaurants, and all the foodstuffs conserved in containers would not tempt our palates or be fit for use when desired if it were not for the careful regulation of temperatures at one stage or another in their preparation. Here it is that Sylphon temperature regulators play an important and a diversified part. The same adaptable apparatus insure every guest in some hotels an ample supply of hot water, and hot water that never oversteps the temperature that prevents scalding. Again, Sylphon regulators automatically control the heat and pressure stages by which crude petroleum is successively "cracked" and made to yield its many useful products; and in the manufacture of rubber goods, the proper degree of heat at certain steps in production is guaranteed by the unfailing action of one or more Fulton bellows. Not only are temperatures maintained in different greenhouses that will best promote growth of the particular plants within them but, after these things of beauty reach the florist, they are kept fresh for days in cold-storage compartments. Here, too, Fulton metal bellows maintain a continual check on the degree of refrigeration.

But it is not in greenhouses only that Sylphon regulators are employed to provide a specified "climate". In the home, the hotel, the office, the movie house, and all sorts of places of amusement and assembly, the temperature of the air can be held within any prescribed range by means of this form of ever-wakeful sentinel. Similarly, the atmosphere in textile mills, in candy factories, biscuit plants, and many other kindred establishments is maintained the year round at temperatures and degrees of moisture most suitable for each of the commodities produced.





Left—Brass melting furnaces that are heated with crude oil atomized with compressed air. Right—Air-operated molding machines in the foundry.

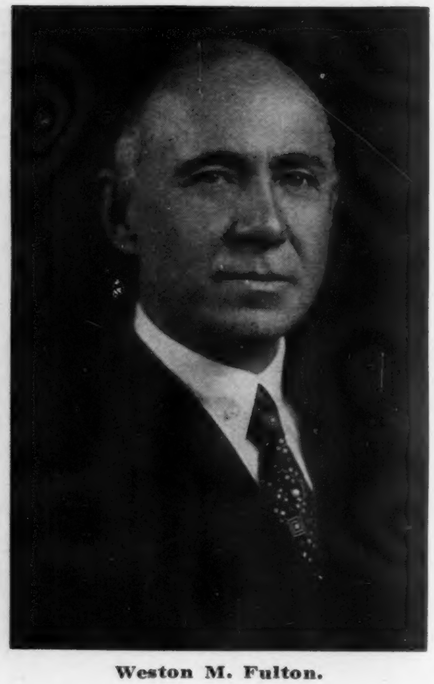


Operating compressed air, over a considerable pressure range, is provided in the plant for many services. Most of this air is used for regular operations, while some of it is utilized in experimental or research work. 1—A 12x10-inch ER compressor. 2—A 4½x5-inch Type 15 compressor in the experimental department. 3—Three 12x10-inch ER compressors furnishing air for general service. 4—This Type 20 stationary compressor delivers air at a pressure of 200 pounds per square inch.

Underground electric cables are now carrying currents of higher voltage than was formerly the practice; and it has become correspondingly more vital to efficient service that the cables and joints be free from electrical leakage. This can be accomplished by impregnating cables of this sort with oil—the problem being to make certain that oil or grease, under pressure, be ever present to fill air pockets and to exclude moisture. This service is now performed by Sylphon flexible all-metal oil reservoirs The expanding bellows force grease in and around the wires of the cable and thus prevent the formation of troublesome voids and the accumulation of impairing moisture. Remember this, when you press the button of any electrical equipment and are rewarded by immediate and perfect service.

So far we have dealt with what might be called peacetime services of Sylphon regulators; but a story could be written alone upon what these apparatus did during the disquieting years of the World War. We shall, however, mention but one of them—the fire control of depth bombs that were employed so effectively in battling with hostile submarines. The problem was to equip the bombs with an adjustable firing mechanism that could be set at will to detonate the high-explosive charge at any desired submergence. Sylphon regulators were cleverly adapted for the service; and thus the U-boat could be wracked seriously or promptly sunk no matter at what depth she was operating.

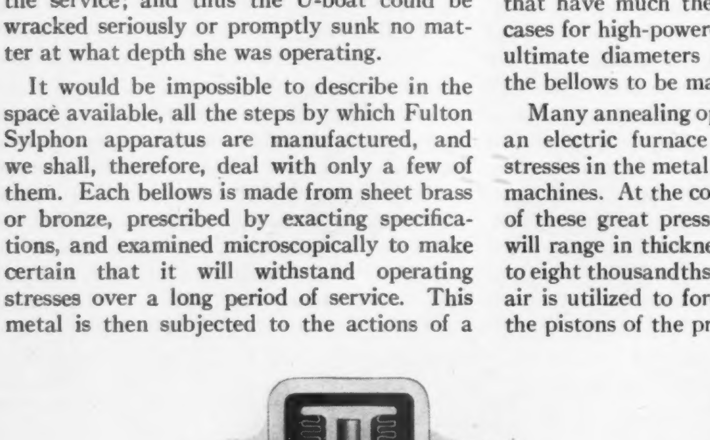
It would be impossible to describe in the space available, all the steps by which Fulton Sylphon apparatus are manufactured, and we shall, therefore, deal with only a few of them. Each bellows is made from sheet brass or bronze, prescribed by exacting specifications, and examined microscopically to make certain that it will withstand operating stresses over a long period of service. This metal is then subjected to the actions of a



Weston M. Fulton.

numerous battery of powerful punching machines, which successively bite out disks from the sheet metal, transform them into cup-shaped pieces, and then, step by step, elongate them into progressively thinner-walled tubes that have much the appearance of cartridge cases for high-powered guns and vary in their ultimate diameters agreeably to the size of the bellows to be made from them.

Many annealing operations are performed in an electric furnace in order to relieve the stresses in the metal set up by the work of the machines. At the conclusion of the operations of these great presses the walls of the tubes will range in thickness from four thousandths to eight thousandths of an inch. High-pressure air is utilized to force the bronze tubes from the pistons of the presses; and compressed air is also employed to blow pieces away from the dies and to atomize the oil of the torches that preheat the dies. The tubes next go to a group of corrugating machines equipped with a series of dies that, step by step, form the tubes into the metal bellows peculiar to the Sylphon apparatus and make them capable of expanding and contracting indefinitely. As a matter of fact, the bellows are tested in machines that can expand and contract a bellows so many times in a relatively brief period that the action is equivalent to the severest operating conditions over a term of several lifetimes. Indeed, every stage of subsequent assembling is subjected to the closest scrutiny; and every one of The Fulton Sylphon Company's products is proved fit for the work expected of it before it reaches the shipping department of the plant.



An adaptation of the Fulton metal bellows for service in connection with an automatic unloader used on Ingersoll-Rand portable compressors. This apparatus does much towards making such compressors troublefree and foolproof.

Compressed air does many things essential to efficiency and operating economy throughout the factory, and this explains why the establishment has a battery of air compressors of various capabilities. Compressed air is used for sand-blasting; for operating molding machines; in firing the cupola of the gray-iron foundry and the brass melting furnace; to actuate cylindrical hoists over hot baths for cleaning brass parts; for opening and closing the chucks of numerous machines; for spray-painting; for various testing or inspecting services; in brazing and soldering work; to raise water from a deep well; for cleaning purposes; and for numerous other duties.

The engineers of The Fulton Sylphon Company are continually engaged in discovering more ways in which the Sylphon can be employed to advantage. This spirit of expanding service never falters, thanks to the example set by Weston M. Fulton in his daily contacts with his organization, which has grown steadily until it has attained its present size of 600 persons in the manufacturing departments. Mr. Fulton points with pardonable pride to the fact that the company has built a business from assets of $50,000 to a valuation of $8,000,000 since 1920! Surely, the world can be glad that his inquiring mind turned from weather forecasting to measuring one of the phenomena of thunderstorms, because an amazingly valuable and varied industry has evolved from the urge of that curiosity.

DIESEL ENGINE ASSOCIATION ELECTS NEW OFFICERS

THE Diesel Engine Manufacturers' Association, which came into being in 1929, has announced the election of the following officers for the year 1930: A. E. Ballin of the McIntosh & Seymour Corporation, Auburn, N. Y., president; George Codrington, Winton Engine Company, Cleveland, Ohio, vice-president; E. T. Fishwick, Worthington Pump & Machinery Corporation, New York, N. Y., chairman, executive committee; H. W. Dow, Nordberg Manufacturing Company, Milwaukee, Wisc., chairman, technical committee; and H. A. Pratt, Ingersoll-Rand Company, New York, N. Y., secretary and treasurer.

Much progress has been made by the association in the relatively short time in which it has been active in promoting the best interests of both the Diesel engine industry and the user. Already, its members have agreed upon certain engineering standards; and these are shortly to be published in convenient book form under the title, *The Standards of the Diesel Engine Manufacturers' Association.*

The new Montreal South Shore Bridge, being built by the Harbor Commission, will be opened to traffic in the spring of this year. From entrance to exit it is two miles long.

How the Dificultad Mine looked at the surface in 1889. At that time the big building housed probably the largest Cornish pump in America.

History of Mexico's Richest Silver Mines

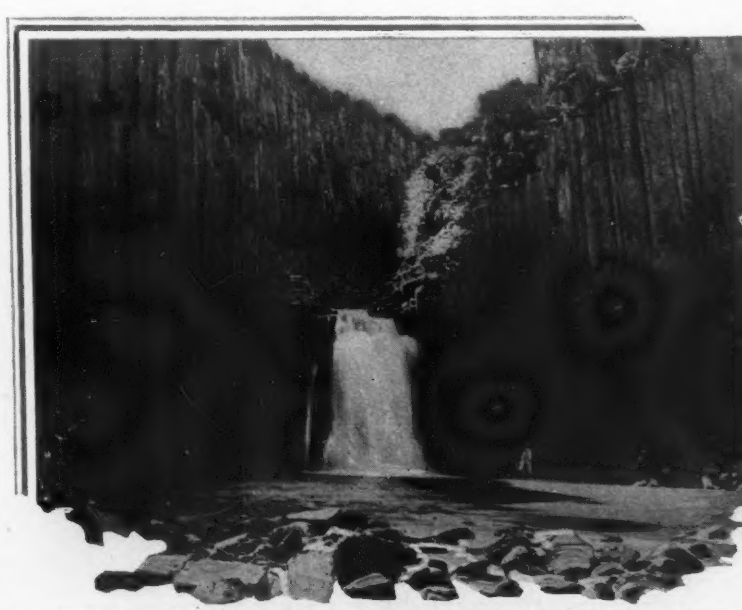
PART II

By J. H. SKEWES

ALTHOUGH the Pachuca and the Real del Monte districts are in close proximity, there is a considerable difference in their vein systems. While the majority of those in Pachuca run east and west, the veins in Real del Monte run north and south. The Vizcaina vein which extends east and west through both districts might be termed the Mother Lode. It has yielded large returns, especially in Pachuca. On this vein are the El Bordo, Santa Ana, San Rafael, and Camelia mines, all of which have been and still are big producers.

In the Real del Monte district the ore taken from the Vizcaina vein occurred in pockets, some of which were extremely rich; but none of this ore was found to be as continuous as that from the same vein in Pachuca. This state of affairs has, at different times, given rise to argument anent the question whether or not it is one and the same vein—some authorities contending that what is known in Real del Monte as the Vizcaina vein is only a fault mineralized along its contacts with the north and south veins.

The early Spanish owners did not seem to recognize the importance of the north and south veins in Real del Monte for, with the exception of the Santa Brígida vein, very little work was done on them. The same thing applies to the Taylor Company. Not until the property came into the hands of the present company were these veins uncovered and extensively exploited. These included the Santa Inés vein which extended from the Dificultad to the Carretera Mine, a matter of a little more than three-fifths of a mile. It yielded large tonnages of rich ore, and was considered one of the bonanzas of the camp. The ore was extracted through the Dificultad and San Ignacio shafts—the separate mines being operated up to 1925. There still is a big reserve of low-grade ore in these workings. Plans are now on foot to mine it.

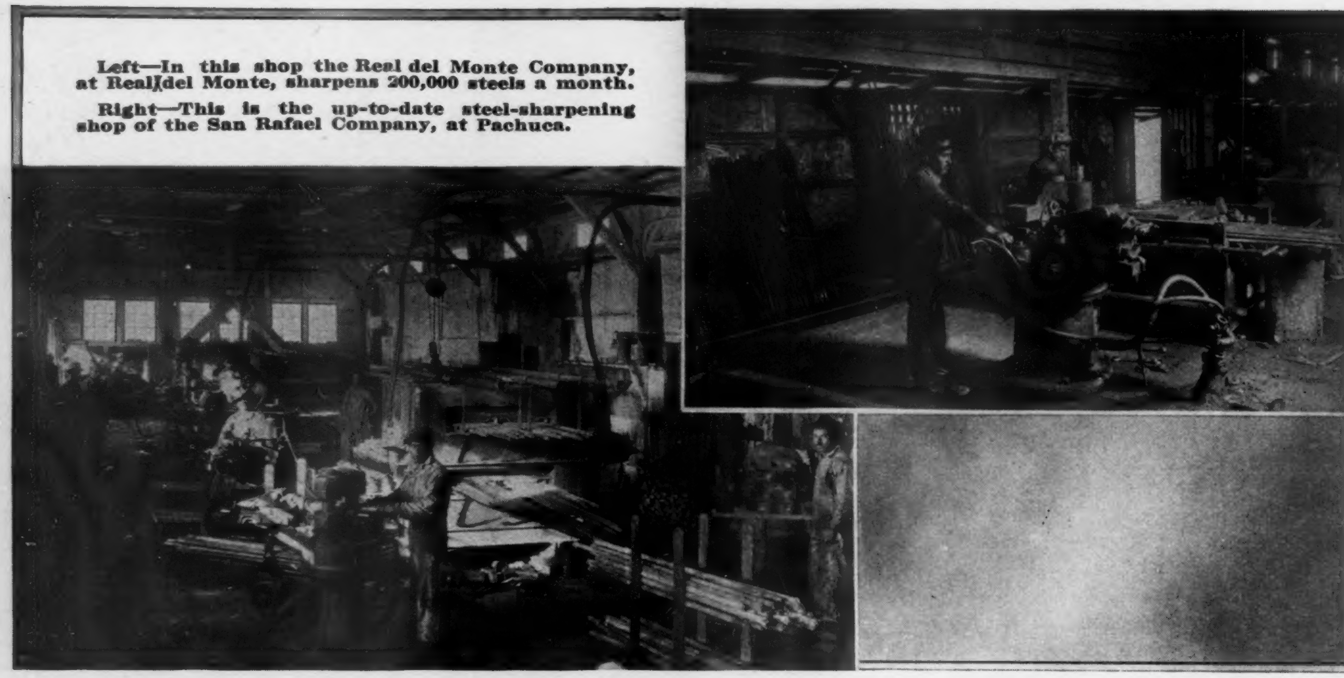


Regla Falls flanked by basaltic columns. The Giant's Causeway of America.

Considerable difficulty was experienced in mining the Santa Inés vein because of seepage, the incoming water reaching a flow of 1,600 gallons a minute. This was handled by two Cornish pumps, one at the Dolores and the other at the Acosta shafts. The pump at the last-named shaft was afterwards moved to the San Pedro Shaft, in Pachuca, for the purpose of unwatering the Rosario Mine.

In 1880, a big steam pump, then one of the largest in the world, was brought from Germany and installed at the Dificultad Shaft. It was a cumbersome piece of machinery, and did not give very satisfactory results. It developed 900 hp., and had a capacity of close on to 2,000 gallons per minute. The huge pump house of cut limestone, with its brick chimney 100 feet high, is still one of the landmarks in Real del Monte. The cost of the pump—including freight, installation, and the pump house—is said to have been 1,000,000 pesos. Charges for its upkeep and operation were very high. Its seven tubular steam boilers consumed about 40 tons of coal every 24 hours. The plant was later dismantled, as were also all the Cornish pumps, and replaced with more modern centrifugal, electric pumps.

To encourage ore production, there was in vogue at that



Left—In this shop the Real del Monte Company, at Real del Monte, sharpens 200,000 steels a month.

Right—This is the up-to-date steel-sharpening shop of the San Rafael Company, at Pachuca.

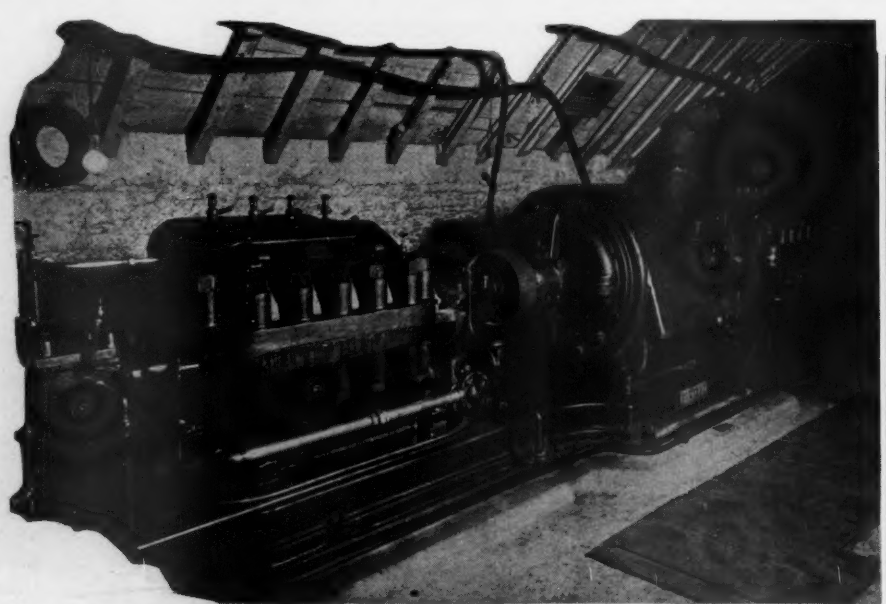
time in almost all the mines a system of compensation called *partido*, under which contractors were permitted to retain in payment for their work one-eighth of the ore broken down by their men. These contractors were supplied with sacks and rope for bagging the ore; and each used a different marker to distinguish his sacks from those of his fellow contractors. These markers were sewed to the sacks, and usually consisted of a piece of fiber string not infrequently ingeniously made to form a cross, ring, lizard, or other distinctive object.

This method of payment involved much assorting of the ore, which was done in large *patios* or yards. As the bags were brought to the surface they were placed, according to their markers, in separate piles, from which each contractor's eighth was taken once a week and stacked for inspection. Friday nights were busy ones at these yards, for then it was that everything was made ready for the company's buyer who made the circuit of the several mines every Saturday morning to purchase back the ore allotted to the contractors—the price being based upon an average assay previously made of the ore. However, the contractors were free to sell to the local buyers in town, if they so preferred. Some of these dealers—who had their own treating plants—did a thriving business, as they also bought ore that was stolen from the mines. After the sacks had been thus handled many times they were emptied, and the ore broken to a convenient size, washed, sorted into three grades, and again resacked for shipment to the mills.

Then there were the *paradas por la casa*—men who worked in pairs, assisted by a *peon*, breaking down ore and cleaning up sections of the veins neglected by the contractors. For this the company paid each man one peso per day, while the *peon* got 50 centavos for his labors. Another practice was that of allowing men to go down into the mines on Sundays and holidays, receiving in payment for their toil one-eighth of all the ore they could produce and sack. This privilege, however, was not accorded only to the miners. As a matter of fact, much favoritism was shown by those in charge; shifters, boss timbermen, pumpmen, and even workers generally otherwise occupied were given preference, while merchants were granted the opportunity of hiring men to mine for them on those days.

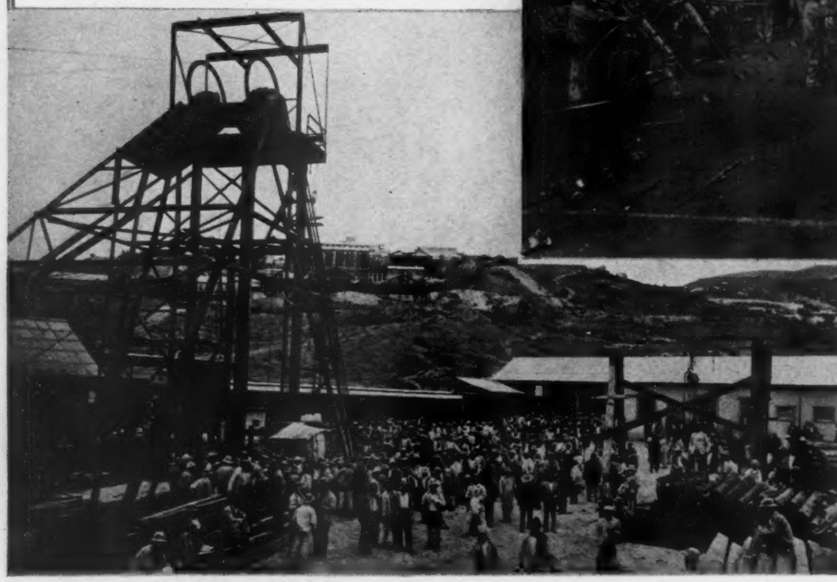
Such methods, obviously, were in many ways detrimental to the interests of the operating company as well as to the workers, themselves. If not closely watched, the miners worked only the richest ore bodies, and did so in a manner that invited danger. Hence the many accidents that occurred and for which scant compensation was made. Ore was left on the walls, many pillars of good ore were buried, and large quantities of pay rock were left in the fills, as was proved subsequently by companies using modern methods of production.

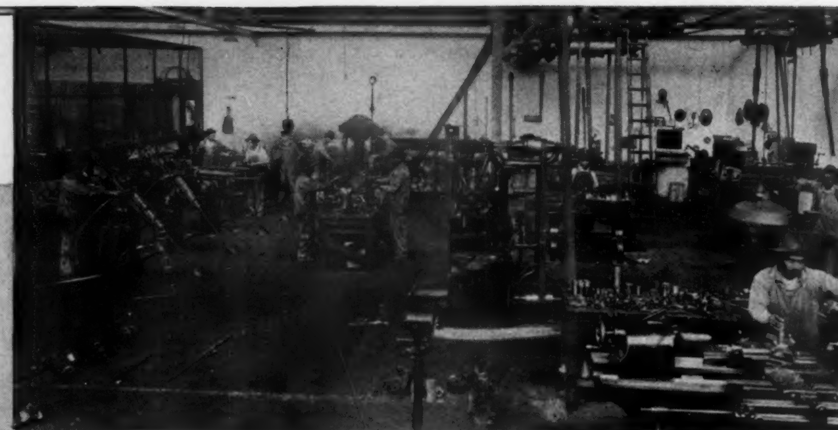
British people then outnumbered the foreigners in the camp; and to Englishmen is due credit for much of the pioneer mining done there. Aside from what the Taylor Company achieved, others of that nationality formed lesser companies, did a lot of prospecting, and discovered several of the veins now being worked. In the Real del Monte district these small-scale operators exploited the Santa Elena, Almoloya, San Esteban, Peregrinos, San Joséde Gracia, Cabrera, La Reina, and numerous other claims. In the Pachuca district they opened up the Santa Gertrudis Mine which, later, turned out to be one of the richest and largest properties in the camp. It was due to the influence and efforts of Capt. Frank Rule, one of the most influential Englishmen of the colony, that the Santa Gertrudis became famous. He also organized the companies which devel-



Two 5-stage Cameron pumps—one delivering to the other—that handle 820 gallons a minute in an actual lift of 1,494 feet at the Dos Carlos Mine.

1—Drilling with a CC-11 stoper on the 1,720-foot level of the San Rafael Mine. 2—An N-38 stoper at work on the 1,310-foot level of the La Rica Mine, at Real del Monte. 3—Three R-72 drifters, mounted on a bar, at the 1,800-foot level of the La Rica Mine. 4—Stoping with an R-51 on the 1,575-foot level of the Camelia Mine, Pachuca. 5—These R-39 "Jackhamers" have proved very efficient in the San Juan Mine at Pachuca.





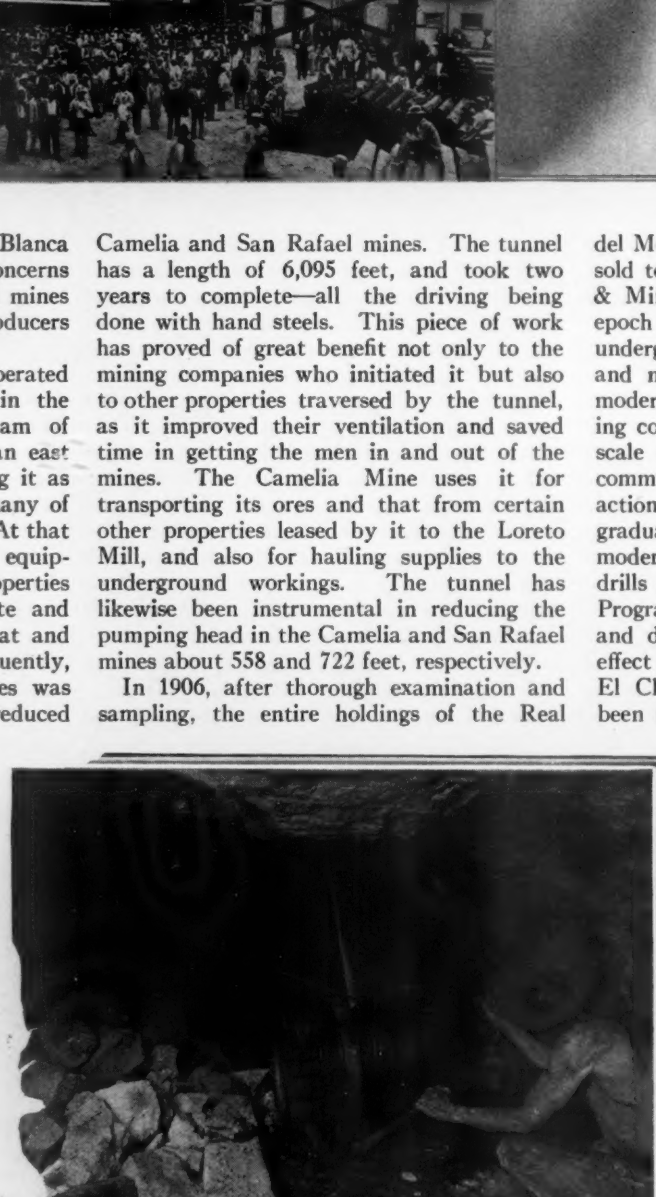
Left—A shift ready to go below in the Dos Carlos Mine of the Santa Gertrudis Company.
Right—The well-equipped general drill-repair shop, at Pachuca, of the Real del Monte Company.

oped the Maravillas, Santa Ana, and La Blanca mines—all big producers. Local concerns started the El Bordo and San Rafael mines which, likewise, are among the big producers of the camp today.

In 1898, at the Camelia Mine, operated by the Real del Monte Company in the Pachuca district, an enormous stream of water was suddenly encountered in an east drift on the 952-foot level, inundating it as well as most of the lower levels in many of the other mines in the neighborhood. At that time the Camelia had no pumping equipment; and the pumps at the other properties in the affected area were inadequate and could not begin to cope with so great and unexpected a volume of water. Consequently, ore production in some of the mines was paralyzed and in others very much reduced for more than a year until additional pumping units could be placed in service. The Real del Monte Company installed two electric pumps in the Camelia Mine; the San Rafael Company increased the number of its pumps—the new ones being larger in size than those already in use; and the Maravillas Company put up a Cornish pump at the El Carmen Mine. By combining forces, the several operators in the field were finally able to get the water under control and, once again, to restore normal working conditions.

In 1899, the Real del Monte Company, in conjunction with the San Rafael Company, began the driving of the Girault Tunnel, which was named after Edmundo Girault who conceived the idea of connecting the Loreto Mill with the Camelia and San Rafael mines. The tunnel has a length of 6,095 feet, and took two years to complete—all the driving being done with hand steels. This piece of work has proved of great benefit not only to the mining companies who initiated it but also to other properties traversed by the tunnel, as it improved their ventilation and saved time in getting the men in and out of the mines. The Camelia Mine uses it for transporting its ores and that from certain other properties leased by it to the Loreto Mill, and also for hauling supplies to the underground workings. The tunnel has likewise been instrumental in reducing the pumping head in the Camelia and San Rafael mines about 558 and 722 feet, respectively.

In 1906, after thorough examination and sampling, the entire holdings of the Real del Monte y Pachuca Mining Company were sold to the United States Smelting, Refining & Mining Company. This marked a new epoch in the camp, for since that time it has undergone a complete change. Both mines and mills have been put on a thoroughly modern basis for quantity production; working conditions have been improved; and the scale of wages raised—in fact, the whole community has benefited through the transaction. All steam pumps and hoists have gradually been discarded and replaced by modern electric machinery; and pneumatic drills are now used instead of hand steels. Programs calling for extensive exploratory and development work have been put into effect in the Pachuca, Real del Monte, and El Chico districts; several rich veins have been uncovered; and some new shafts have been sunk and old ones carried to greater depths.

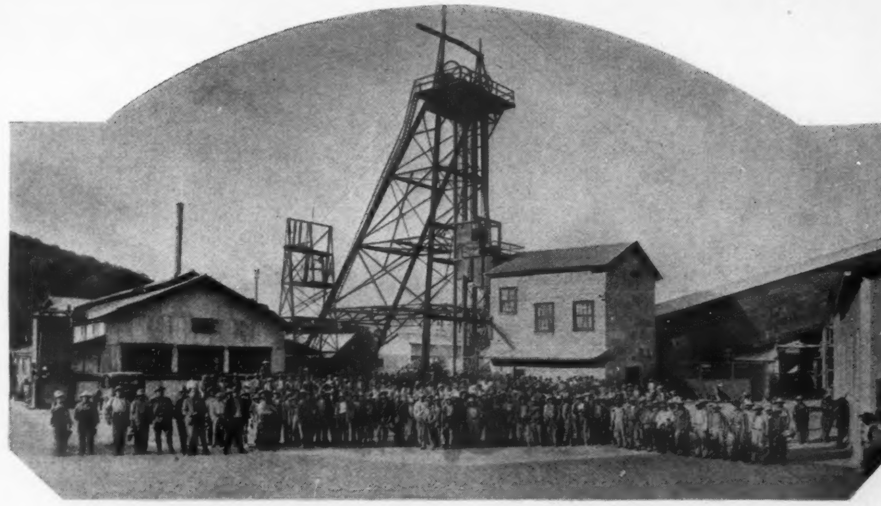


The air-driven hoist has proved extremely efficient in slushing operations in the Camelia Mine of the Real del Monte Company.

In 1914 the famous Purísima vein was cut in the Real del Monte district after continuing the Guardaraya crosscut from the Dificultad Mine for a distance of about 230 feet to the west on the 1,312-foot level. This vein proved to be a bonanza and, undoubtedly, one of the most productive ever found in the camp. It was then said to be one of the longest-known silver fissure ore bodies in the world. Its total continuous length was in excess of two-thirds of a mile, and the pay values were found to extend from a depth of 492 feet to the 2,264-foot level. For developing this ore body, a shaft was sunk from the surface to the 1,312-foot level. It was timbered with steel sets, at an average speed of

33 feet weekly, and equipped with an electric hoist and a compressor plant. It has since been carried down to the 2,132.5-foot level.

Other rich veins opened up in the Real del Monte district by the United States Smelting, Refining & Mining Company are the La Rica and the Dios te Guie, which have been made accessible by a shaft that was sunk on the La Rica property. This shaft is also steel timbered; is 1,968.5 feet deep; and is provided with two electric hoists. Exploratory crosscuts on the 1,312-foot level from the Dolores and the La Rica mines revealed that the north-south veins continued beyond the Vizcaina east-west fracture; and in this area were opened up the Santa Margarita and the Sr. San Jose mines. Another important discovery made in recent years was the Dos Carlos vein system located by the Santa Gertrudis Company by cutting crosscuts from the old Santa Gertrudis working.



Workers at the La Rica Mine of the Real del Monte Company, Pachuca.

The Acosta Shaft is now the main hoistway for the Real del Monte district, having replaced the San Ignacio Shaft which had been used for that purpose since 1910. The Acosta Shaft is equipped with crushers underground and with an electric hoist at the surface. The hoist has a maximum speed of 1,400 feet per minute, and is driven by a 500-hp. motor. Self-dumping skips, with a capacity of 5.5 tons, are used for hoisting the ore. From there an aerial tramway carries it to the Guerrero Mill, about 1½ miles distant. On the site of the old *hacienda* now stands a modern cyanide-process plant that has a capacity of about 1,300 tons daily. Water for use in the mill is pumped from the Aviadero Tunnel through the chimney shaft, which has been reconditioned and provided with electric pumps that run automatically. The Escobar and Cabrera mines, which produced small tonnages for a long while, have been worked out; but an electric pumping plant is still maintained at Cabrera for keeping the water out of some of the nearby mines.

Most of the properties in the Real del Monte district which have at different times been in the hands of small local companies have been taken over by the United States Smelting, Refining & Mining Company, the only organization operating there at present. The total output of the district is about 2,200 tons a day.

In the Pachuca district, the old Loreto Mill, which was equipped to use the patio process, has been remodeled and now treats approximately 2,750 tons of ore daily by the cyanide process. The Santa Ana group of mines in the same region and the Arévalo mines in El Chico were purchased by the company, and aerial tramways constructed for transporting the ore to the Loreto Mill. The Santa Ana mines have been connected underground with the San Juan Shaft, which adjoins the Loreto Mill. The ore from these workings is carried to the shaft by electric haulage and is also hoisted electrically to the mill storage bins.

When underground connections now being driven from the Fortuna or 886-foot level in the San Juan Mine in Pachuca and from the 1,805-foot level in the La Rica Mine in Real del Monte are completed, then all the ore from those districts will thus be hauled and hoisted electrically to the Loreto Mill. The Guerrero Mill will then be done away with. To this end, the Loreto Mill is being enlarged to take care of the total tonnage from all the company's mines, which is in excess of 110,000 tons monthly.

Another important operator in Pachuca is the Santa Gertrudis Company. This company, which came to the field in 1909 and purchased several properties from local concerns, is exploiting the El Bordo, Santo Tomás, and Santa Gertrudis group of mines, as well as the Dos Carlos properties—an entirely new discovery that is yielding rich returns. All the ore from the Santa Gertrudis Company's mines is treated at a large and up-to-date mill using the cyanide process.

Other operators in the Pachuca district are the San Rafael Company, with a large group of mines and a mill two miles north of the town, and the Guadalupe Fresnillo Company which is developing a small group of mines about a mile east of Pachuca and treating the ore in the Purísima Grande Mill. The San Rafael Company's properties have for years and still are producing steadily.

At the present time, the total monthly output of all the silver mines in the Pachuca, Real del Monte, and El Chico districts is something like 220,000 tons, yielding approximately 90 tons of silver and 1,070 troy pounds of gold. And to keep all the underground workings in the field in proper condition, the pumps are required to handle around 10,000 gallons of water every minute. Electric power is supplied the district by the Mexican Light & Power Company from three of its plants situated at Regla, Cuandó, and Necaxa, the last-named furnishing most of the current needed.

Putting down exploratory borings at an angle in a limestone district near Sao Paulo, Brazil, with a G-33 "Calyx" core drill, which uses "Calyxite"—chilled steel shot or crushed steel—instead of the far more expensive black diamonds to do the cutting. Core drills of this size can bore their way through any substance down to depths ranging between 50 and 250 feet.

EDWARD AUSTIN RIX

TO his many friends and business associates, the announcement of the death of Edward Austin Rix, on January 8, will be received with profound regret. Mr. Rix' career, brought to a close at the end of his 74th year, was an active and a brilliant one. He was a pioneer in the development of compressed-air apparatus and in the application of compressed air in industry. On that subject he wrote such well-known works as: *A practical treatise on compressed air and pneumatic machinery; Oil well pumping by compressed air; The compression and transmission of illuminating gas,* and *Some economics in high pressure gas transmission.* He was a mathematician of exceptional ability, and contributed much towards the advancement of science.

After his graduation, in 1877, from the University of California, he served first as apprentice and then as foreman of the Phoenix Iron Works. In about five years he acquired the ownership of those works, and there he designed and built pneumatic tools and equipment, refrigerating machinery, engines, locomotives, stamp mills, power tramways, etc. In 1890 he sold his interests in the Phoenix Iron Works and entered the engineering business. This he pursued on a large scale. Subsequently he organized what is now known as The Rix Company, Inc., of San Francisco, Calif., and of this concern Mr. Rix was president and manager at the time of his demise.

NEW MACHINE TESTS SOUNDNESS OF WIRE ROPE

THE Applied Science Department of the University of Sheffield, in coöperation with various British collieries, has recently brought to successful conclusion an important piece of research work that had to do with the development of electromagnetic apparatus for the testing of wire rope. This subject has also been engaging the attention of the American Society of Mechanical Engineers; and what has been accomplished abroad should be of interest to the users of wire rope in the United States. While the apparatus was mainly produced for the purpose of detecting internal flaws in winding ropes in coal mines, still it can be employed to test the soundness of wire rope of any kind and for any service.

To prevent accidents, to safeguard life and property, the British Mines Act makes it compulsory to replace colliery winding ropes after 3½ years of use, because it has not been possible in the past to detect internal weaknesses by non-destructive methods. Under the circumstances, the precautionary measure has been thoroughly justified; but it has probably meant putting many ropes out of commission long before their useful lives were over. As such ropes may cost as much as $5,000 and more, it can be appreciated what the new electromagnetic testing machine is going to signify to wire rope users generally.

INVESTMENTS OF UNITED STATES CAPITAL IN LATIN AMERICA, by Max Winkler, Ph.D. A work of 297 pages, published by the World Peace Foundation, Boston, Mass. Price, $2.00.

DOCTOR Winkler's book is said to be the first detailed presentation of a subject which is of far-reaching importance in our relations with the republics to the south of us. Inevitably, the vast sums so invested must make for closer relations and stronger bonds of reciprocal regard and understanding. Freer intercourse and wider knowledge of the problems of the nations so interested are bound to benefit all concerned—each giving and receiving in return to the common good of all.

The fact that most of the great public utilities in Latin America are foreign enterprises, and to an increasing extent are enterprises organized and financed in the United States, will make clear why Doctor Winkler's volume should be read by every one intent upon fostering business between us and the sister countries to the south. A great many of us are unaware of the extent of our participation in Latin-American progress.

PROSPERITY, FACT OR MYTH, by Stuart Chase. A work of 188 pages, published by Charles Boni, New York City. Price, 75 cents.

PROSPERITY, as Mr. Chase envisions it, is not a single general state but one made up of four main divisions of economic well-being—each having to do with a different department of our national life, and with the business, industrial, and social reflexes of these arbitrary groupings. One prosperity concerns business and commerce, including the volume of output and the measure of employment; a second prosperity depends upon the distribution of products and services intended to benefit the ultimate consumer; a third prosperity is that measurable in the amount of security and leisure enjoyed by the average citizen; while a fourth prosperity is indicated by a prevailing atmosphere that contributes to the beautiful things of life, as that term is employed more or less freely.

Mr. Chase has attacked his problem with a creditable degree of open-mindedness, and he has arrayed the facts collected by him—pro and con prosperity, as he gages it—in a way that reveals his desire to be impartial. The outstanding virtue of Mr. Chase's presentation is that he shows that prosperity has numerous angles; and, such being the case, we just naturally wonder whether prosperity of a thoroughly balanced sort can be realized. As we see it—accepting the author's subdivisions—prosperity must inevitably be a compromise so long as human relations, human lines of endeavor, and human aspirations are divergent or diversified.

"MANNA-HATIN" THE STORY OF NEW YORK. An illustrated book of 269 pages, published by the Manhattan Company, New York, and distributed by the Bank of Manhattan Trust Company, Inc.

THIS interestingly written volume is not intended to be a history of the Metropolis but rather a story that crystallizes the high points in the development of this great city of world-wide economic and commercial importance. The work will enable the hastening reader of today to obtain a broader popular understanding of the outstanding stages by which New York has attained to its present eminence among the cities of the world. The book will incidentally serve to inspire the youth of the present to carry on the responsibilities that will be theirs in the years to come in keeping the Metropolis always at the forefront in those things that count most in human relations.

TOMORROW'S ADVERTISERS, by George Harrison Phelps. A volume of 256 pages, with some illustrations, published by Harper & Brothers, New York, Price, $3.50.

THE questions are asked: "What does the future hold for advertising? How will it function in tomorrow's merchandizing scheme? What flaws are there in present advertising practice—and how must they be eliminated by the advertiser and his advertising agent?" Manifestly, these questions trouble the minds of many people—those that render advertising service as well as those that pay the bill in the end. The author has done an excellent piece of work in trying to answer the questions stated. He is an advertising man of long experience and of eminence in his calling; and the pages of his book bear evidence of this in the wealth of valuable advice and information presented by him. The volume fills a long-felt want.

Cameron Hydraulic Data, an illustrated handbook issued by the Ingersoll-Rand Company, 11 Broadway, New York City. The present volume is the eighth edition of a work that has won wide popularity, and of which more than 66,000 copies have already been distributed. No inconsiderable part of the data presented originated among the company's own engineering organization; and much of the information represents the solution of difficult pumping problems. The book should be helpful to the men who have to meet special conditions in the varied field of pump service.

Granite Cutting is the title of Bulletin No. 137, issued by the Federal Board for Vocational Education, Washington, D. C. It can be obtained from the Superintendent of Documents, Washington, D. C., for 50 cents. The purpose of the bulletin is to aid in training apprentices in the granite industry; and much care has been exercised in describing and in detailing the many aspects of the subject in a manner that would be readily understandable to the average youth seeking to qualify as a granite cutter.

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